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AUTOMOBILE BEVEL DRIVE GEARS*

FORGING, MACHINING, HEAT-TREATING, INSPECTING AND ASSEMBLING

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THE main drive employed in transmitting power from the engine to the rear wheels of an automobile comprises several gears and parts which are difficult to make. The two gears (excluding the transmission and equalizing or compensating gears) which receive the greatest care and attention at the hands of the progressive automobile manufacturer, are the main bevel gear and pinion. It is safe to say that these two parts have caused more trouble than probably

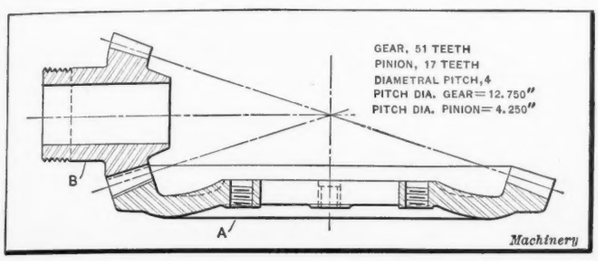

Fig. 1. Main Bevel Drive Gear and Pinion in Mesh

any other part about a car. Extreme care has to be exercised from the time the material is purchased until the gears are completed and working satisfactorily in the rear axle housing. The slightest defect in any of the manufacturing processes is likely to unfit these gears for use, necessitating scrapping them, probably when they are almost ready to be put into place; hence, it is absolutely necessary that each step be followed closely, and the gears "checked-up" after each important operation. In the making of these two gears most manufacturers differ to a slight extent, so that it may be of interest to explain here, briefly, how these two parts are produced by the White Co., Cleveland, Ohio, for use in its various motor cars.

Forging Operations

After the steel has been tested and found to be O. K., the flat bar (containing 5 per cent nickel and from 14 to 18 points carbon), used for making the main gear, is cut up into blocks of a length sufficient to fill the impressions in the dies and

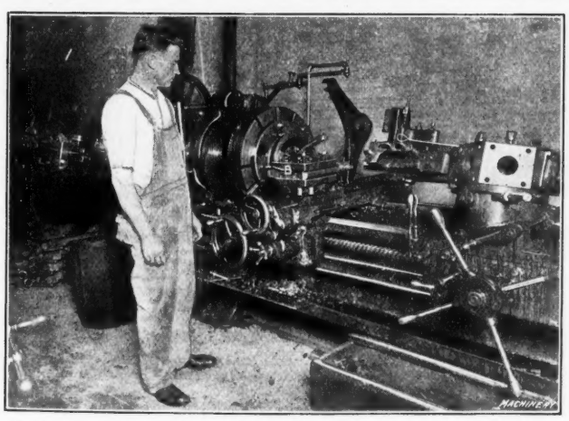

Fig. 2. Rough-machining Large Bevel Drive Gears in a Gisholt Turret Lathe

also allow for a tang by which the blank is held when being drop-forged. The block is first taken to a power hammer where one end is reduced, making a tang by which the operator can grip the block with the tongs. The block is again heated, and by successive tools held in a power press, is split in the center and expanded into a ring. The object in doing this is to make the "grain" of the steel follow in a circle as much as possible, making it easier to harden without twisting. For the bevel drive gear *A*, shown diagrammatically in Fig. 1, the block is about 4 inches thick, and slightly greater than half the finished diameter in width to start with. Then after being formed into a ring, it is heated and passed through a breaking-down die, which rough-forms it ready for the final drop-forging operation.

For the final forging operation, the bevel gear blank is heated to a bright red in a muffle furnace, and upon reaching

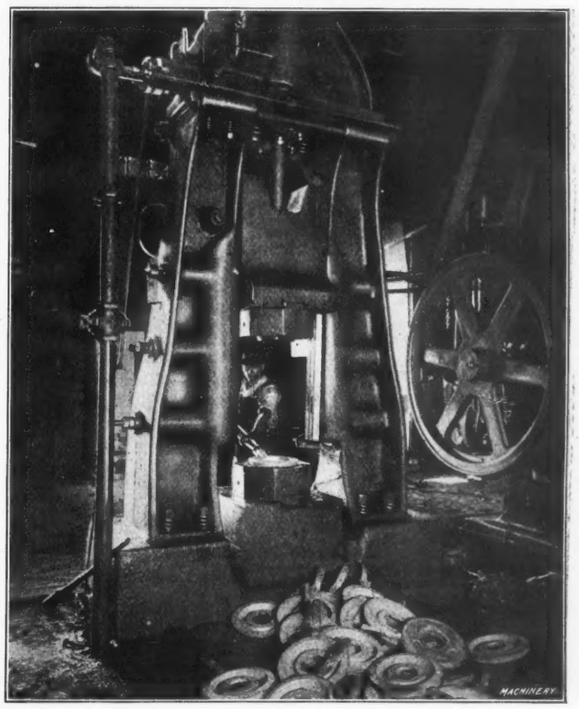

Fig. 3. Drop-forging Large Bevel Gears under a Chambersburg Steam Hammer

the desired temperature is removed by the operator and placed under the steam hammer shown in Fig. 3. It requires two men to attend to this work; one man looks after the heating of the blanks while the other operates the drop hammer. The drop-forging dies for the final operation are held in a 10,000-pound Chambersburg steam hammer, where the blanks receive from two to three blows. The number of blows required depends upon the material, temperature to which the blank is heated, and the character of the work. This particular gear blank is given two blows, then the flash is trimmed in the power press shown to the right of the illustration, after which the blank is given a final blow and thrown down in the sand to cool off. A heap of finished forgings is shown in the immediate foreground, where the general contour of the gear blank is clearly shown. The tank is sheared off in a power shear after the forgings are cold.

The bevel pinion is more easily and quickly made. It is cut from a round bar and formed into the desired shape by two drop-forge die impressions, one for breaking down or rough-forming and the other for finish-forming. The flash

* For additional information on the manufacture of gears used in the construction of motor cars see the following articles previously published in MACHINERY: "The Design and Manufacture of a High-grade Motor Car," October, 1909; "Manufacturing Automobile Equalizing Gears," December, 1909; "Design of Automobile Transmission Gears," October and December, 1910, and January, 1911, engineering edition; "The Heald Internal Grinding Machine," February, 1912; "Analysis and Heat Treatment of Low-carbon and Alloy Steels," August, 1912.

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formed during the drop-forging operation is removed in a trimming die. The amount of metal required to fill an impression is generally determined by trial, but the operator soon becomes so proficient in this work that he generally "hits" the correct amount of stock the first time. When a part of a similar shape and size is obtainable, the amount of stock can be ascertained by weighing the stock and blank, allowing a slight excess to form a tang and to provide for the amount of material lost in "flashing." [For additional information on drop-forge dies, see the articles on "Drop-forge Die-sinking," which appeared in the September, August and July, 1911, numbers of MACHINERY, and other articles there referred to.—EDITOR.]

Machining—Turret Lathe, Engine Lathe, and Gear-Cutting Operations

Before the gear blanks are brought to the machining department, they are taken to the hardening department and "air treated." This operation consists in placing the blanks in a muffle furnace, and heating them to about 1700 degrees F. The gear blanks are then removed from the furnace and

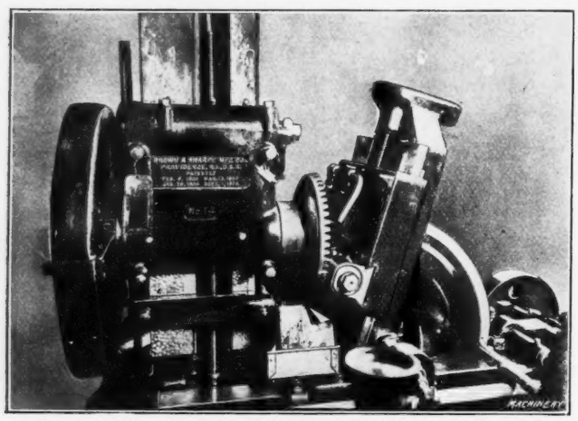


Fig. 4. Gashing the Teeth in the Large Bevel Gear in a Brown & Sharpe Automatic Gear-cutter

allowed to cool gradually in the air. In the following description attention will be given to the processes employed in machining the main bevel gear, but practically the same methods are used in producing the pinion, with the exception, of course, that fixtures especially adapted for holding it are employed.

For the first machining operation, the large bevel gear is gripped in a chuck in a Gisholt turret lathe, the hole is bored and reamed and the boss faced. The next machining operation is illustrated in Fig. 2. Here the partly machined gear is

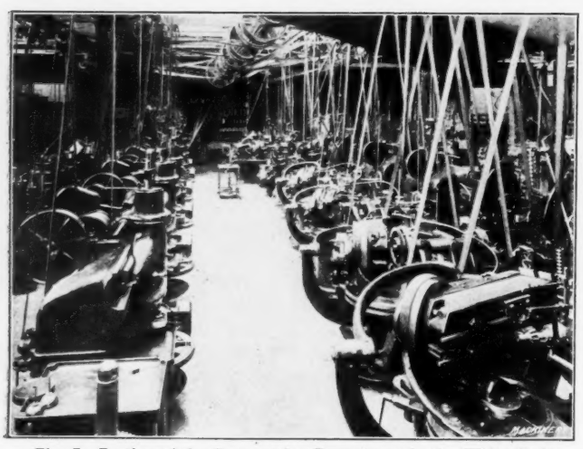


Fig. 5. Portion of the Gear-cutting Department in the White Co.'s Plant, Cleveland, O.

clamped to the fixture *A* by bolts passing through the four bolt holes which have been drilled previous to this operation. The fixture *A*, which is held to the faceplate of a Gisholt turret lathe, is provided with a boss fitting into the hole in the gear, and is also supplied with four spring studs *B*, supporting the rim of the gear. Because of the shape of this gear, it is necessary that the rim be supported to resist the thrust of the cutting tools, which is considerable.

The operations performed on the bevel gear in the set-up shown in Fig. 2 are of a roughing nature only, and consist in taking a roughing and finishing cut from the bevel face, inside face, and rear bevel. The front bevel face is roughed out with a tool held on the cross-slide, and finished with two tools held in a holder fastened to the turret. One of these tools in the turret finishes the inside face. One-quarter inch of material is removed from the front face, and ⅛ inch from the inside face. The back face is machined with a tool held

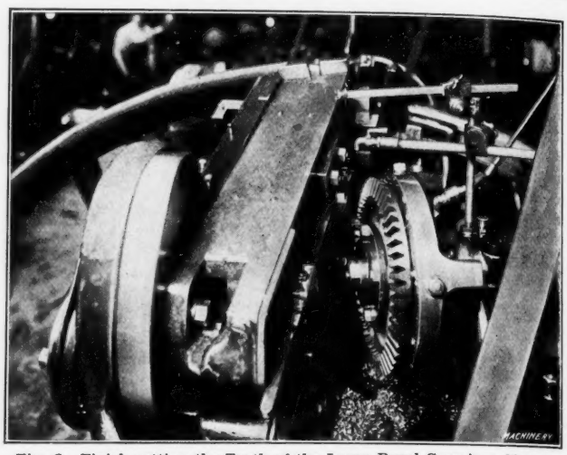


Fig. 6. Finish-cutting the Teeth of the Large Bevel Gear in a Gleason Bevel Gear Generator

in the tool-post, removing ⅛ inch of material. The roughing operations on this gear are handled very expeditiously in the Gisholt turret lathe, the time being 4¼ minutes for one gear, approximately.

From the turret lathe the large bevel gears are taken to the Brown & Sharpe automatic gear-cutter shown in Fig. 4, where the teeth are roughed out, or "gashed" as this operation is generally called. A regular bevel gear stocking cutter is used for this operation, which leaves just enough material

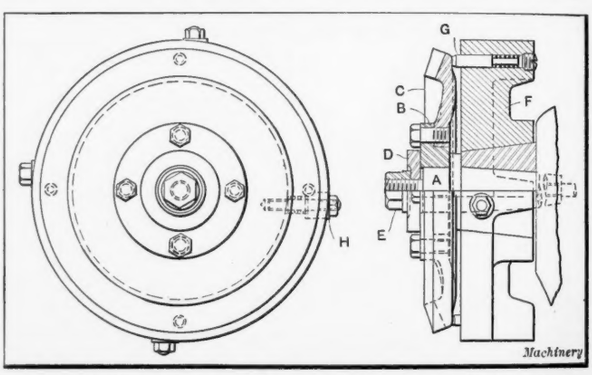


Fig. 7. Fixture used on the Gleason Bevel Gear Generator for holding the Large Bevel Gear when cutting the Teeth

(about 1/64 inch on a side) for finishing up on the Gleason bevel gear generator. While being "gashed" the gear is clamped by a washer and nut to a special fixture fitting on the nose of the spindle.

Upon the completion of the "gashing" operation, the gears are taken to the hardening department, where they are annealed to relieve the strains set up in forging and machining. Annealing previous to rough-machining would not relieve the strains set up in the blank, owing to the fact that the outer or hardened surface produced in drop-forging acts as a binder and does not allow the grain of the steel to "set" properly. The gears are packed for annealing in charcoal and placed in iron boxes. These are then placed in the furnace shown in Fig. 9, which is heated by coke, a temperature of about 1600 degrees F. being attained. The gears are left in this furnace for a period ranging from three to four hours, when the boxes are taken from the furnace, and allowed to cool in the air without removing the contents. This treatment removes all forging and machining strains, bringing the structure of the steel to its normal condition.

The bevel gears are taken to the lathe department after

annealing, where light finishing cuts are taken from all machined portions of the gears. The face and back angles are at this time machined to the correct angles, and the hole in the gear reamed to the exact size. Upon the completion of these operations, the gears are ready to have the teeth finished to their final shape in the Gleason bevel gear generators, a general view of which appears in Fig. 5. This illustration shows a section of the gear-cutting department. The bevel gear generator shown to the right in the immediate foreground is at work finishing the teeth in the bevel pinion, while the machine immediately behind this one is finishing the teeth of the large bevel gear. This illustration also shows a row of Fellows gear shapers, which are employed principally in producing transmission gears.

Generating Bevel Drive Gear Teeth

The rotary cutter method of producing bevel gears is used to a large extent for slow-running gears, but for gears which must rotate at high speeds and where noise is objectionable, this method is not advisable. The bevel gears used in an automobile not only rotate at high speeds, but also transmit power under a great variety of conditions, and if not properly made and hardened soon become noisy and inefficient. To eliminate noise, it is necessary that the tooth curves or "rolling circles" be correctly formed and that the teeth be of an equal thickness at the pitch line. There are also other factors, such as the shape of the teeth, method of mounting, etc., which contribute to the production of noise.

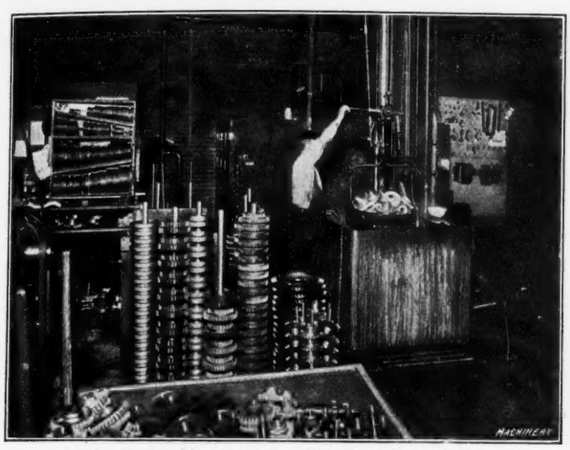


Fig. 8. Washing Gears in a Hot Soda Water Bath

Now the problem confronting the automobile manufacturer is not only to be able to produce quiet-running bevel gears, but to produce gears in large quantities, interchangeable, and as cheaply as possible. The method generally pursued is to rough out the teeth in an automatic gear-cutter, and do the finishing in a bevel gear generating machine. The automatic machine made by the Gleason Works is used largely by the automobile manufacturers for this purpose. A close view of one of these bevel gear generating machines at work on a bevel drive gear is shown in Fig. 6.

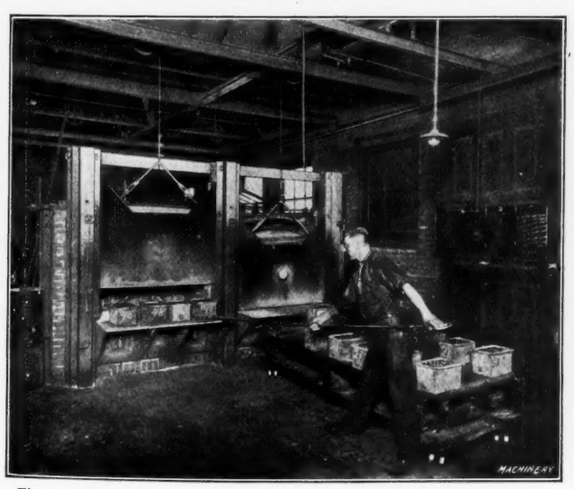


Fig. 9. Coke Fuel Furnace used in carburizing Gears and Other Parts

The principle on which this machine works, described briefly, is as follows: Assuming that the bevel gear (the teeth of which have previously been rough-formed) is fastened to the work spindle in the proper manner, and that the machine has been properly adjusted in its preliminary position, the tool-slide and head on which it is mounted is swung around so that the tools clear the work. The machine is now started, whereupon a cam swings the cutter-slide head inward until the tools reach the proper depth. This cam movement now rocks the semi-circular arm extending around the front of the machine, upward, rotating the work spindle carrying the blank, and at the same time, through the segmental crown and master gears, rocking the tool-slide until the two shaving tools have been rolled out of contact in one direction, and thus partially forming the gear tooth. The semi-circular arm is now rolled back to the central position, continuing downward to the lower position until the tools are rolled out of contact with the gear tooth, and in this movement completely forming the gear tooth.

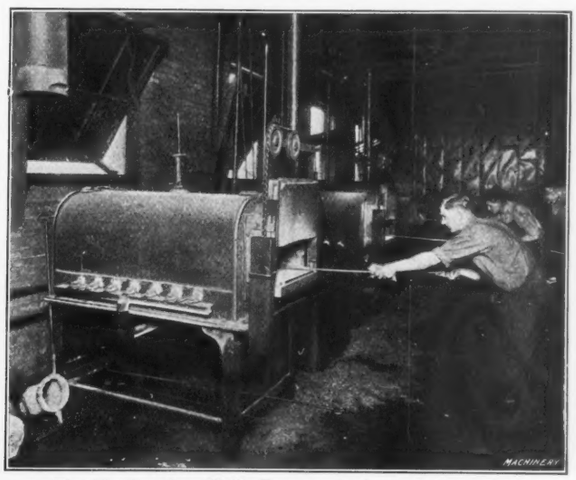


Fig. 10. American Muffle Furnaces for heat-treating Gears and Other Parts

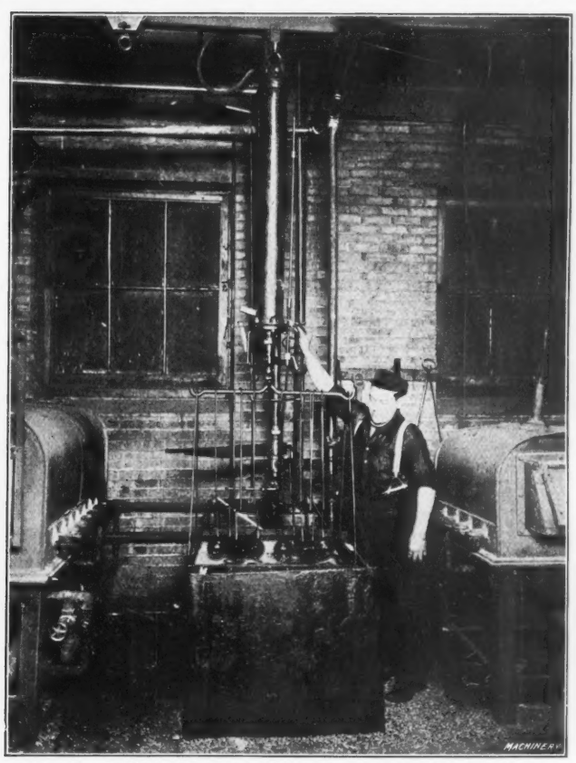


Fig. 11. Cooling Gears for hardening in Oil Bath—Compressed Air Arrangement used for agitating Oil

To bring the machine into the indexing position, the cam

then rocks the semi-circular arm back to the central position, where the cutter-slide head is swung back to clear the tooth, and the work spindle is indexed, after which this cycle of operations is repeated for the succeeding teeth. By following this principle of operation, it is evident that the two cutters which are used are passed twice over each tooth. They start from the center of the tooth, go to each extreme and return, so that each tooth of the gear receives a roughing and finishing cut. The use of two tools—one on each side of the tooth—presents a number of advantages. Not only does it increase the working capacity of the machine, but it

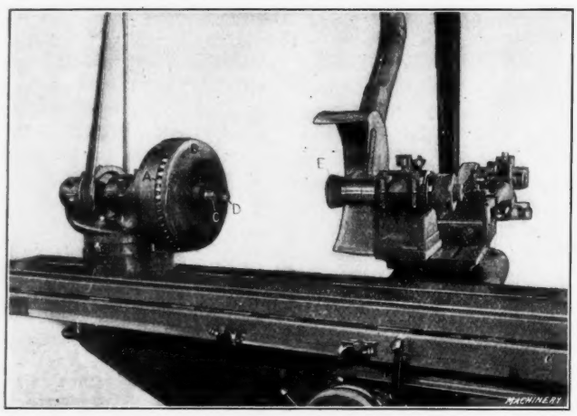


Fig. 12. Grinding Back Face of Large Bevel Gear in a Brown & Sharpe Universal Grinding Machine

also balances the thrust of the cutting action on the two sides of the tooth and reduces chatter and vibration to a minimum, giving greater accuracy. The slides in which the tool blades are carried are adjustable to accommodate different sizes of teeth. This machine is entirely automatic in its operation, and as it works on the molding-generating principle, receiving its shape controlling action from a crown and master gear in mesh, it is possible to produce a theoretically correct-shaped tooth, which is very essential in bevel gears that must transmit power at high speeds. [The Gleason bevel gear generating machine was described in the August, 1908, and July, 1906, numbers.—EDITOR.]

In finish-machining the large bevel drive gear, particular care is taken to see that the hole and front inner face or boss are accurately machined and true with each other, as

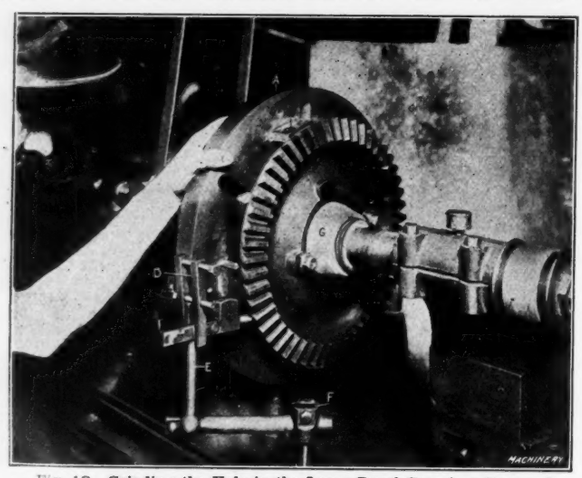


Fig. 13. Grinding the Hole in the Large Bevel Gear in a Brown & Sharpe Universal Grinding Machine

these two points are used in all important machining operations for locating purposes. Special fixtures are therefore used in the succeeding operations for holding the gear, the latter always being located from these two points.

The special fixture used in holding the large bevel gear when generating the teeth in the Gleason bevel gear generator is shown in the close view of this machine in Fig. 6 and also in detail in Fig. 7. Referring to the latter illustration, the fixture consists of the spindle *A* fitting in the tapered hole in the spindle of the machine, and carrying the shoulder plate *B* on which the gear *C* is held by cap-screws fitting in the bolt holes. The spindle *A* is hardened and ground all over, and those portions of the shoulder plate which come in contact with the spindle or gear are ground. The plate *B* is held up against the shoulder on the spindle *A* by a slotted washer *D* and nut *E*.

Retained on the tapered nose of the machine spindle by a set-screw is the cast-iron plate *F*, in which four spring pins *G* are held for supporting the rim of the gear against the thrust of the cutting tools. The nuts binding the clamping washers *H*, which press against the spring plungers, are released after the gear has been clamped on the spindle, allowing the springs behind the plungers to force the latter out against the rear face of the gear; then the nuts are tightened to clamp the plungers in this position. The chief object of securing the gear in this manner is to approximate as closely as possible the actual position in which the gear is held to the compensating case. Two shoulder plates similar to that shown at *B* are made, so that when one gear is being finished, the operator can be clamping a rough gear to the other plate, getting it ready for the machine.

Heat-treating

After the teeth have been finished, the gears are taken to the hardening department where all oil and fine chips are removed from them by immersion in a bath of hot soda water. This operation is illustrated in Fig. 8, where a basket full of transmission and bevel pinions are being washed. A compressed air device connected to the basket is used for

Fig. 14. Fixture used in testing Large Bevel Gears for Truth after grinding Back and Front Inner Faces

moving the latter up and down in the bath, which action agitates the fluid and assists in removing all oil and fine chips quickly. After three or four immersions the gears are removed from the basket and allowed to dry.

Following the washing of the gears they are packed in boxes in a carburizing compound (composed chiefly of granulated bone), these, in turn, being placed in the carburizing furnaces shown in Fig. 9. The temperature in these furnaces is raised with coke fuel to 1650-1700 degrees F., and the boxes are allowed to remain in the furnace for from ten to twelve and one-half hours. They are then removed from the furnace, and allowed to cool gradually in the air, the contents not being removed until cold.

The next step after carburizing is to wash the gears in hot soda water, using the arrangement shown in Fig. 8, after which the gears are packed in boxes with charred leather, the latter being placed in the American muffle furnaces illustrated in Fig. 10. These furnaces are heated by gas to a temperature of 1600 degrees F., and the gears are allowed to remain in the furnace until they attain this temperature. The boxes are then removed from the furnace and the gears taken out, after which they are clamped by a key in a special fixture and quenched in oil. This fixture, which holds the gear, prevents it from becoming distorted during the cooling operation. For quenching, the gears are placed in the basket shown in Fig. 11 which is moved rapidly up and down by the compressed air arrangement shown.

The operator opens the valve controlling the compressed air hoist, which carries the basket and gears up and down in the oil bath, cooling the gears and at the same time agitating the oil to assist in uniform cooling. In Fig. 11, the gears shown suspended from the arm are some of the gears used in the transmission case. When cold, the gears are unfastened from the fixture and tested to see whether they have become distorted during the hardening process. If distorted no attempt is made to straighten them by mechanical means alone, but the gears are again placed in the furnace, brought to the proper temperature and cooled as previously described. This treatment seldom fails to bring a distorted gear back to its original shape. Usually the temper of the gears is drawn

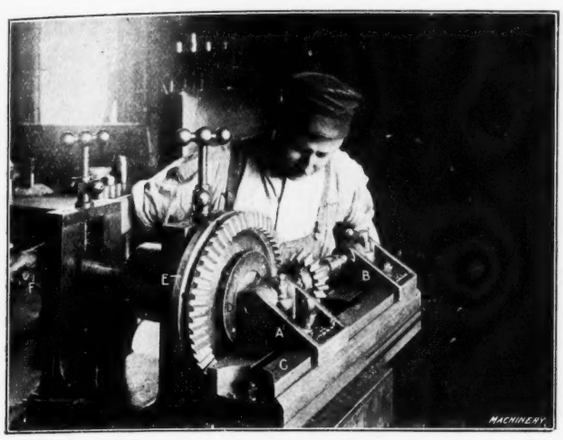


Fig. 15. Running Test on Bevel Gear and Pinion, accomplished by Hand to test for Noise

after hardening; this operation is accomplished in an oil bath heated to a temperature of from 300 to 325 degrees F., and in which the work is allowed to remain for about one hour, being then cooled off gradually. [For a fuller description of the methods used in heat-treating automobile parts made from low carbon and alloy steel, reference should be made to the article on this subject in the August, 1912, number of MACHINERY, entitled "Analysis and Heat-Treatment of Low Carbon and Alloy Steels."—EDITOR.]

Grinding Operations

The next important operation on the main drive gear is the grinding of the back face in a Brown & Sharpe universal grinding machine as shown in Fig. 12. To accommodate this gear, the greatest diameter of which is almost thirteen inches, it is necessary to pack up the internal grinding head and also the headstock so that the gear can be swung. For this grinding operation, the gear is located from the pitch line of the teeth by 24 steel balls—one placed every second tooth space—and located in a circular groove in a special plate *A*. Gear *B* is held up against the balls in the groove of plate *A* by a hardened and ground shouldered sleeve *C*. This sleeve is located on the special arbor fitting in the spindle of the headstock, and fits the hole in the gear, the shoulder bearing against the back face. The sleeve is pinned to the arbor by a removable pin, and is acted upon by a block *D* backed up by a nut and washer. This nut and washer are held on a pull rod which passes completely through the headstock spindle and is used for drawing the gear up against the steel balls.

To remove the gear from the fixture, the tension of the pull rod on block *D* is released, when the latter, which is slotted, is removed, as is also the removable pin. When this is done the steel balls drop out from between the lower teeth of the gear, then the fixture is rotated until all of the balls have dropped out and have been caught in the operator's hand. Sleeve *C* and the gear are now removed and a rough gear put on. The pin and block are then put in place, the pull rod drawn up slightly and the balls dropped in between the teeth from the top, the fixture meanwhile being rotated by hand to replace all of the balls. The pull rod is now drawn up tightly and the back face of the gear ground true with the "pitch circle" of the gear by the bevel cup-wheel *E* held on the internal grinding spindle in the usual manner.

The next grinding operation on the main drive gear is in the hole. To accomplish this, a special faceplate is fitted to the headstock of a Brown & Sharpe universal grinder as shown in Fig. 13. The faceplate *A* is provided with four lugs *B*, the faces of which have been accurately ground. The previously ground face of the gear (which operation is illustrated in Fig. 12) is held against lugs *B* by two nuts threaded on two bolts passing through from the back of the faceplate and fitting in the bolt holes in the gear. These clamping bolts are smaller in diameter than the bolt holes in the gear, thus enabling the clamping to be done by the nuts. As in the case of the previous grinding operation, the headstock and the internal grinding head are raised by special blocks to accommodate this gear. The gear is trued up from the outside beveled edge by the test indicator *C*, held by the clamp *D* to the swinging arm *E*, retained in stud *F* which is pivoted in the platen of the grinder. The hole is ground to size and true with the outside and back face, by the bevel cup-wheel *G*, held on the internal grinding spindle. After this, the front inside face is ground true with the hole and back face, the gear being held on a fixture somewhat similar in construction to that shown in Fig. 13 for this operation.

Testing and Inspecting

Now that the grinding operations have all been accomplished on this gear, the next step is to ascertain whether these operations have been correctly performed or not. The inspecting fixture used in determining whether or not the back face and inside front face are true with the "pitch line of the teeth," is shown in Fig. 14. This fixture consists of a

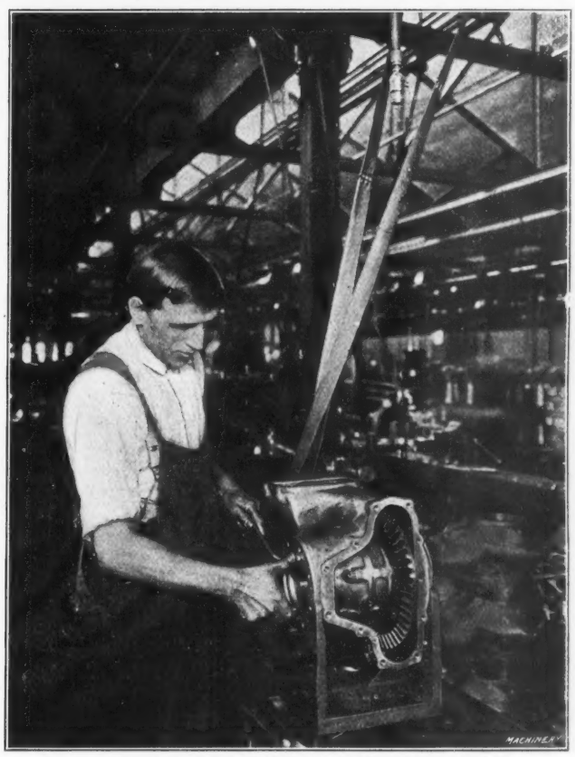


Fig. 16. Adjusting Main Drive Gear to Pinion, when assembled in the Rear Axle Housing

cast-iron base *A* to which a hardened and ground steel ring *B* is fastened. A circular groove for retaining a "ring" of steel balls is provided in the top face of this ring, and on these balls the back face of the gear rests. The gear is located from the hole by a hardened and ground stud *C* which is fastened to the cast-iron base.

The test for truth is accomplished with the test indicator *D* held in the bracket *E* by a clamp and thumb-nut. Bracket *E* is retained on a stud projecting up from the fixture, and is free to swing on this stud when the clamp shown is released. The inspector in testing for truth, rotates the gear on the balls with his hands, as shown, and at the same time

watches the movement of the indicator needle to see if any inaccuracy has taken place in the grinding operations. One of these inspecting fixtures is also kept in the grinding department, and is used by the grinding machine operator (the one who grinds the inside face of the gear) to determine whether the final grinding operation has been successfully accomplished or not before the gears leave his department.

Assuming now that the bevel pinion, on which the machining operations have been similarly conducted, is completed, this and the large bevel gear are taken to the inspection fixture shown in Fig. 15, where they are run in mesh and tested for noise. The testing fixture is applied to a Lincoln type milling machine, and is composed of two brackets held on the table, and a special holder for the large gear. The brackets *A* and

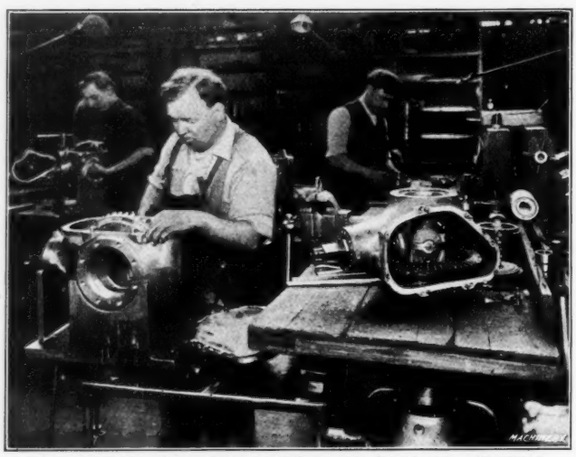


Fig. 17. Assembling Drive and Compensating Gears in the Rear Axle Housing

B which carry centers retaining the pinion arbor are held to the special table *C* by T-bolts and nuts. The bracket *A* is provided with a wing-nut so that it can be easily moved to insert and remove the work.

The large gear is held in a similar manner to that employed in the Gleason bevel gear generator, being located from the front inside face by a shoulder plate *D* to which the gear is bolted. Spring pins located in the special faceplate *E* are also used to support the rim of the gear, as was the case in the fixture shown in Fig. 7. This old type of Lincoln miller, see Fig. 15, is provided with a special hardened and ground spindle on which the fixture is retained. The spindle is hollow and a pull rod passing through it is used to clamp the gear and shoulder plate *D* up against the fixture. To the rear end of the spindle the handle *F* is attached, which is used to rotate the large gear meshing with the pinion held on the arbor. The operator brings the gear and pinion into proper contact, and then rotates the handle slowly, listening carefully to find out at which points of the rotation any noise is produced, or where the teeth bear hard.

Assembling

The gear and pinion are not mated until ready for the noise test, and if they pass this satisfactorily they are then ready for assembling. Before the bevel gears can be assembled it is necessary that the compensating gears, also known as "differentials," be assembled on the spider and fastened in the compensating case. The large bevel gear is then fastened to the compensating case as shown in Fig. 16. The compensating case and gear are then put inside of the rear axle housing, the ball bearing put into place, and the spanner nuts screwed in, retaining the entire mechanism. After this the bevel pinion (for the smaller sizes this is made integral with the shaft) is assembled on the shaft and located in its proper position in the rear axle housing, the ball bearings first being put into place. The spanner nuts are now tightened and the entire mechanism lined up. An assembled rear axle drive is shown to the right of the illustration in Fig. 17.

Before the spanner nuts holding the various members in the rear axle housing are tightened up, the main drive gear is adjusted to the pinion. This is accomplished as shown in Fig. 16, where the assembler is shown in the act of adjusting the spanner nuts retaining the ball bearings and compensating case. The case is moved back and forth by the spanner nuts, and the bevel pinion is rotated by a belt running on a pulley on the bevel pinion shaft. The pinion is also adjusted up and down (in relation to the large gear) until the teeth of both are flush at the back. When these operations have been accomplished, this unit of the power plant is complete.

In the preceding paragraphs only a brief description is given of the manufacture of this interesting part of an automobile, but from this can be obtained some idea of the ingenuity and skill necessary to build a successful motor car. The writer wishes to express his appreciation of favors bestowed by Mr. James A. Harris, Jr., advertising manager of this company, in furnishing the information and photographs presented in this article.

* * *

TO DETERMINE THE SIZE OF RAIL NECESSARY TO CARRY A GIVEN LOAD

BY R. H. CREVOISIE*

Frequently it is necessary to determine the size of wheel or rail required to carry a given load. In such cases, the following formulas may be employed. Let

A = the width of the head of the rail in inches;
B = width of the tread of the rail in inches;
C = the wheel-load in pounds;
D = the diameter of the wheel in inches.

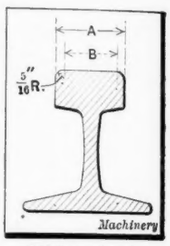
Then the width of the tread of the rail in inches is found from the formula:

$$B = \frac{C}{1250D} \qquad (1)$$

The width A of the head equals $B + \frac{5}{8}$ inch.

The diameter D of the smallest track wheel that will safely carry the load is found from the formula:

$$D = \frac{C}{A \times K} \qquad (2)$$



Section of Rail

in which

K = 600 to 800 for steel castings;
K = 300 to 400 for cast iron.

As an example, assume that the wheel-load in a given case is 10,000 pounds and that the diameter of the wheel is 20 inches, and the material steel casting. Determine the size of rail necessary to carry this load. From Formula (1) we find:

$$B = \frac{10{,}000}{1250 \times 20} = 0.4 \text{ inch.}$$

Hence the width of the rail required equals $0.4 + \frac{5}{8}$ inch = 1.025 inch.

Determine also whether a wheel 20 inches in diameter is large enough to safely carry the load. From Formula (2) we find:

$$D = \frac{10{,}000}{1.025 \times 600} = 16\tfrac{1}{4} \text{ inches.}$$

This is the smallest diameter of track wheel that will safely carry the load; hence a 20-inch wheel is ample.

* * *

CELEBRATION OF DISCOVERY OF LOGARITHMS

The Royal Society of Edinburgh, Scotland, is considering the celebration of the anniversary of the tercentenary of the discovery of logarithms, which occurs in 1914. John Napier, who is generally credited as being the discoverer of logarithms, was born near Edinburgh in 1550. His work on logarithms was published in 1614. The importance of logarithms in mathematical computations can hardly be overestimated. They undoubtedly constitute the greatest time- and labor-saving system ever discovered in the realm of mathematics. The slide-rule, so generally used by engineers for making calculations, depends upon the properties of logarithmic scales for its usefulness.

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STANDARDS IN DIE WORK*

In the construction of dies, the design depends, of course, upon the general character of the work, and for each new form a little valuable experience is usually obtained. In designing various kinds of dies, it is impossible to state specifically just how each one should be constructed, but it is practicable to have some standard parts and rules that can be relied upon and are based upon the fact that they have been tested in actual practice and found satisfactory. For example, it has been found by experience that die-beds for presses, when built of gray iron, get out of square, in time, and sometimes crack, whereas the die-bed does not deteriorate when made of semi-steel. It is the practice of large firms to so design blanking and cutting dies that the minimum of steel is used, probably because of the cost, and to back the steel by welding a wrought iron plate to it. The wrought iron plates that seem to meet most of the requirements for all-around work are of the following sizes: 4 inches by 8½ inches, 5 inches by 9 inches, 6 inches by 9½ inches, 7 inches by 10½ inches, 8 inches by 11½ inches, 10 inches by 13 inches and 12 inches by 15 inches. The corners of these plates as a rule are cut at a 45-degree angle.

The cutting edges of blanking dies are made of steel of some stock size, which varies from ¾ to 1¼ inch in height and from ¼ to 1 inch in thickness, depending upon the use and application of the die. It has been found cheaper, for many dies, to weld steel edges to wrought iron in preference to screwing or bolting them to cast iron. To prevent heavy stresses, especially at the starting point, the designer should provide plenty of shear. In blanking dies, the punch should never touch the die, and a clearance of 5 per cent of the thickness of the metal to be cut should be allowed; for example, with material 0.03 inch thick, allow 0.0015 inch all around.

It is customary to shear the face of the die when possible, but there are instances when it is advisable to shear the punch. The shear is given to the punch when the material removed is to be scrapped and the outside piece used. The face of the die is sheared when the piece punched out is the product. The amount of shear necessary depends upon the thickness of the stock and the size of the cut. A general rule is to allow 1/16 inch shear up to 2 inches diameter; 3/32 inch up to 4 inches diameter; 1/8 inch up to 6 inches diameter; 5/32 inch up to 8 inches diameter; 3/16 inch up to 10 inches diameter; 7/32 inch up to 12 inches diameter; 1/4 inch up to 14 inches diameter; 9/32 inch up to 16 inches diameter; and 5/16 inch up to 18 inches diameter. The shear of the die usually begins at the center and extends toward each end, the number of high spots depending upon the class of work, etc. In stripping work from blanking dies, a standard stripper is commonly used. This is simply a piece of steel rod with one end squared and bent at right angles, and the other end forced into the die plate close to the outer edge of the steel, with the bent edge turned toward the cutting edge so as to strip the work.

For clamping dies, right-angle slotted plates are used extensively. These are from 1¼ inch to 2⅛ inches in height, 3½ inches to 7 inches in length and 2½ inches to 3 inches in width. The thickness varies from ⅝ inch to 1 inch, with a slot averaging ⅞ inch in width and about 2 inches long. Standard round dies are used to a great extent, ranging from ⅛ inch to ⅞ inch, in the following approximate dimensions: for dies varying in size from 1/8 inch to 9/32 inch: diameter, ¾ inch; height, ¾ inch; depth of cutting edge, ¼ inch; clearance, 3 degrees; and relief under the cutting edge, 1/32 inch. On sizes from 11/32 inch to ⅞ inch, the diameter is from 1 inch on the small sizes to 1½ on the largest sizes, and the height, 1 inch. The relief averages 3/32 inch; the clearance 3 degrees; and the cutting edge, ½ inch. These dies are held in position by a set-screw bearing against the side of the die, or by a die-screw which depends upon the projecting head of the screw for its holding power.

The die governs the size of the work passing through it and the punch governs the size of the work it passes through, so that the clearance governs the result. In blanking dies, the die is made the size of the work wanted, but in perforating, the punch is made the size of the work wanted and the die larger. In boiler work, the practice for the clearance of punches is to make the punch 1/64 inch below the nominal size and the die 1/64 inch above the nominal size, thus giving 1/32 inch clearance for all sizes up to 1 1/4 inch. For all sizes above 1¼ inch, the punches are left the nominal size and the dies made 1/32 inch larger. The taper on dies below 1¼ inch, is 1 inch in 12 inches, and above 1¼ inch, the taper is ½ inch in 12 inches.

There are two types of standard punches for the standard round dies; namely, the straight shank and the headed punch. The straight shank is used with standard punch-holders, which are either screwed or clamped into the press slide. Punches varying from 5/32 inch to 7/16 inch in diameter have shanks from 1/2 to 11/16 inch in diameter, length of from 2¼ inches to 3¾ inches, and a clearance varying from 0.002 to 0.005 inch. The headed type has a bead 1/8 inch larger than the shank and 1/8 inch thick. This type is used a great deal when the punches are held to a cast-iron punch-holder by means of a steel plate screwed to the holder. In some cases where there are a great number of punches, or the thrust is excessive, a steel plate is inserted behind the punches to prevent them from working through the holder.

The lubricant used with dies is a very important factor and many times good tools are ruined by using the wrong lubricant. For brass and steel, use any heavy animal oil, and when drawing steel shells, use equal parts of oil and black lead or heavy grease with a small percentage of white lead. For copper and German silver, cover the material with a thin coat of lard or sperm oil before punching, and for drawing brass or copper, use a solution composed of 15 pounds of Fullers soap to a barrel of hot water (used hot) or soap strong in rosin or potash. For zinc, use hot water, while for aluminum, use lard oil, melted Russian tallow and vaseline applied on both sides of the metal.

The speed of presses for re-drawing work should average from 50 to 60 revolutions per minute and the pressure should vary from 200 to 400 pounds. The ordinary cutting speeds for dies in quick-running presses range from 50 to 200 strokes per minute, and the average, 100 strokes per minute on shearing and punching metals not over ¼ inch thick. Safe cutting pressures in pounds per square inch are as follows: Mild steel, 60,000; wrought iron, 50,000; bronze, 40,000; soft brass, copper, and cast iron, 30,000; aluminum, 20,000; zinc, 10,000; tin, 5000, and lead, 5000.

* * *

CONCRETE BUILDING IN RECORD TIME

The unloading of sheet steel in a new concrete building nine days after the contract for it was let, the installing in it of punch presses weighing from twelve to nineteen tons twelve days later, and the operating of ten big punch presses on twenty carloads of material just a month from its inception, is the record achieved by the Crocker-Wheeler Co. of Ampere, N. J. Mr. W. J. Warder, Jr., was appointed works manager of this concern on October 1, 1912, and the necessity for acquiring a new punch press department to take care of the tremendous influx of orders which has been common to all manufacturers this fall was quickly realized. A concrete building 80 by 80 feet and 15 feet high, with a monitor roof down the center to accommodate a five-ton crane was planned. At noon of the day following the decision of the officers of the company to build, the contract was let. Nine days later the long strips of sheet steel, the material to be punched, were being unloaded into the building. Twelve days later the heavy punch presses, the biggest of which weigh nineteen tons, were being placed on the concrete floor. Exactly one month from the inception of the building twenty carloads of sheet steel were in it being punched by the ten big punch presses, a full equipment of dies and grinders for the dies was installed, and the installation was operating at maximum capacity as an integral permanent unit of the Crocker-Wheeler plant.

* * *

Be just as free to answer questions as to ask them. The best way to learn is through a fair exchange of ideas.

* Abstract of a paper presented before the American Society of Engineer Draftsmen, by Mr. Charles A. Clark.

LUCAS JACKS, PROPS AND BRACES

An ingenious and simple unit system of jacks, props and braces is used with general satisfaction by the Lucas Machine Tool Co., Cleveland, Ohio, on planers, boring machines, boring mills and other machine tools.

The system comprises eight varieties of units; these can be assembled in an almost endless number of combinations and lengths of jacks, heels for straps in close places, braces, etc. The system is not only simple and efficient but it very materially reduces the investment in work clamping accessories, as compared with those usually provided for planers and similar machines. It is scientific in design and meets

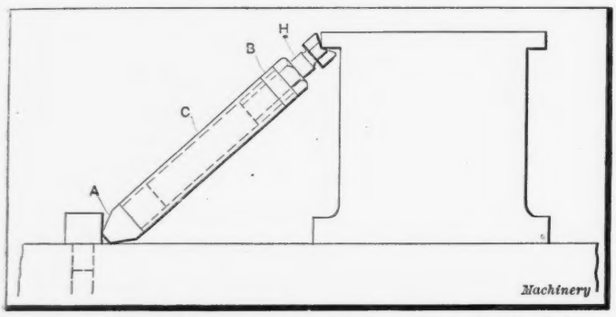

Fig. 1. Combination employed as a Brace in planing a Machine Bed

one of the requirements of scientific machine shop management.

Fig. 1 shows a typical combination employed as a brace for a machine bed. It is composed of the parts *A*, *C*, *B* and *H*, all of which are shown in detail in Fig. 2; this view also shows alternate parts at *E*, *F*, *D* and *G*. Unit *C* is 1¼ inch pipe cut in lengths, varying by 4 inches; *B* and *F* are alike excepting in length, one being 2 inches longer than the other. These are used alone for short lengths and in the end of the pipe units *C* for longer lengths. The fact that part *F* is 2 inches longer than *B* makes it possible to have a difference of length of 4 inches in the pipe units and still have a series of over-all lengths of the combinations varying by 2 inches.

GERMAN SILVER

German silver is a white alloy consisting of nickel, copper, and zinc, the best quality being made up of four parts copper, two parts nickel, and two parts zinc. This quality, however, is the most difficult to work. It is known under probably a greater number of names than any other alloy. In this country and England it is known as nickel silver, packfong, white copper, silveroid, Nevada silver, and electrum. It is very ductile, and can be hammered, rolled, stamped, and drawn; at the same time it possesses the properties of being hard, tough, and not easily corroded.

Iron, lead, and tin are frequently found as impurities in German silver. Iron alloys perfectly with it, increasing the strength, hardness, and elasticity of the alloy, at the same time making it whiter. Tin, on the other hand, does not enter into the alloy in the same way as iron, but forms a mixture which renders it brittle and unfit for rolling. Even when present in small quantities it gives the alloy a yellowish color. Lead does not alloy with German silver, but separates out as metallic lead. When the alloy is to be cast and subsequently turned upon a lathe, from 2 to 3 per cent of lead is added, as it enables the lathe to be worked at a higher speed, and gives a better finish to the work.

German silver is made by melting the metals in graphite crucibles. In order to produce a more homogeneous alloy and to lessen the oxidation of the zinc, the separate metals are not melted together, but alloys of copper and nickel, and copper and zinc are used, and shortly before pouring a small quantity of zinc is added to overcome the effect of the volatilization of the zinc and to insure a thorough deoxidation of the alloy.

The metal is cast in iron molds previously heated and coated with oil or mixtures of charcoal and oil, or rosin and oil. The temperature of casting is a very important point. If the temperature is too high, the metal will be full of blowholes and will crack in rolling. If, on the other hand, it is cast at too low a temperature it tends to solidify as it touches the mold, with the result that there is imperfect cohesion of the metal. As the melting point of German silver is higher than that of brass, it must be cast rapidly, or the crucible must

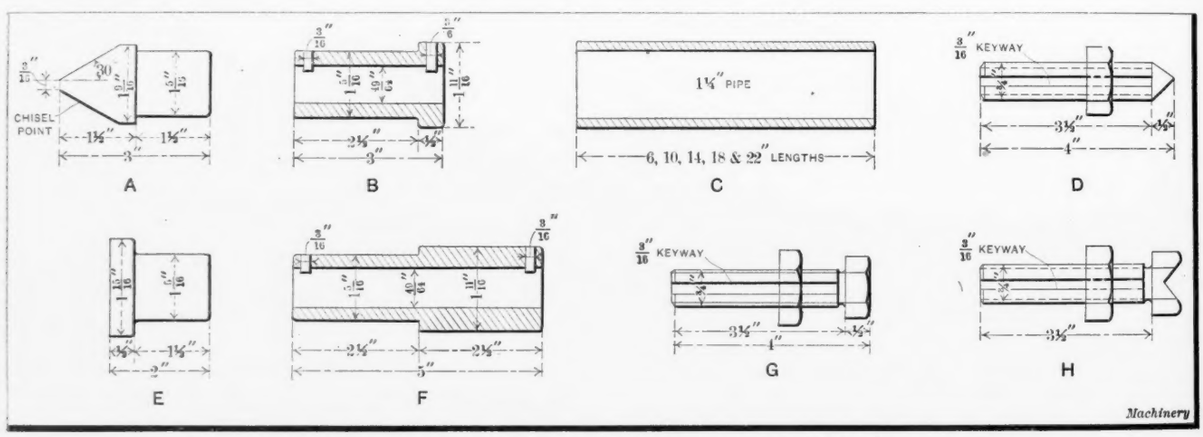

Fig. 2. Eight Units that can be combined to form a Variety of Braces, Jacks and Other Clamping Accessories

This saves one-half the number of pipe units that would be necessary if only one length of part *B* or *F* were provided.

Three forms of screw points are furnished for use with *B* or *F*, these being shown at *D*, *H* and *G*. Pins are provided to engage the keyways and hold the screws from turning when they are used as jack-screws. The pins are put in both ends of *B* and *F* so that the screws may be used in either end, the screw being preferably placed in the small end when making up a short jack-screw combination. The units *A* and *E* are placed in the pipe ends opposite the jack-screws, and provide pointed or flat end support as the case may require.

* * *

Moving pictures will be used by the Central Georgia Railroad to teach the elements of railroading to employes, many of whom are illiterate. It is believed that in this way comparatively ignorant men can be taught to perform their duties more intelligently.

be returned to the furnace and be reheated. If the metal is to be rolled into sheets, molds from 16 to 18 inches long, 4 to 5 inches wide, and 1 to 1¼ inch thick are used. When intended for wire the molds are 4½ to 5 feet long, 3¼ inches wide, and 1¼ inch thick.

German silver, besides being used for many scientific instruments, is frequently used as a base in cheap grades of silver-plated ware. German silver, containing 60 per cent copper, 14 per cent nickel, 24 per cent zinc, and 1 to 2 per cent tungsten, is used under the name of platinoid for electrical resistances. It has also been alloyed with silver for jewelry and subsidiary coinage. Aluminum and magnesium have also been alloyed with German silver, but owing to the high cost, these alloys have never found extended uses.

German silver can be readily soldered. The usual composition of German silver solder is: Copper 47 per cent; nickel, 11 per cent; and zinc, 42 per cent.—*Things Technical.*

VAN WAGNER MFG. CO.'S DIE-CASTING PRACTICE—2

THE CASTING MACHINES AND DIES USED IN PRODUCING PRESSURE CASTINGS

BY CHESTER L. LUCAS*

Next to the casting machine, the dies or molds are the most important necessary factor. The Van Wagner Co. takes special pride in its diemaking equipment, and a general view of this department is shown in Fig. 16. In order to gain a proper conception of the work required in producing a high-grade die-casting mold, we will follow the different steps

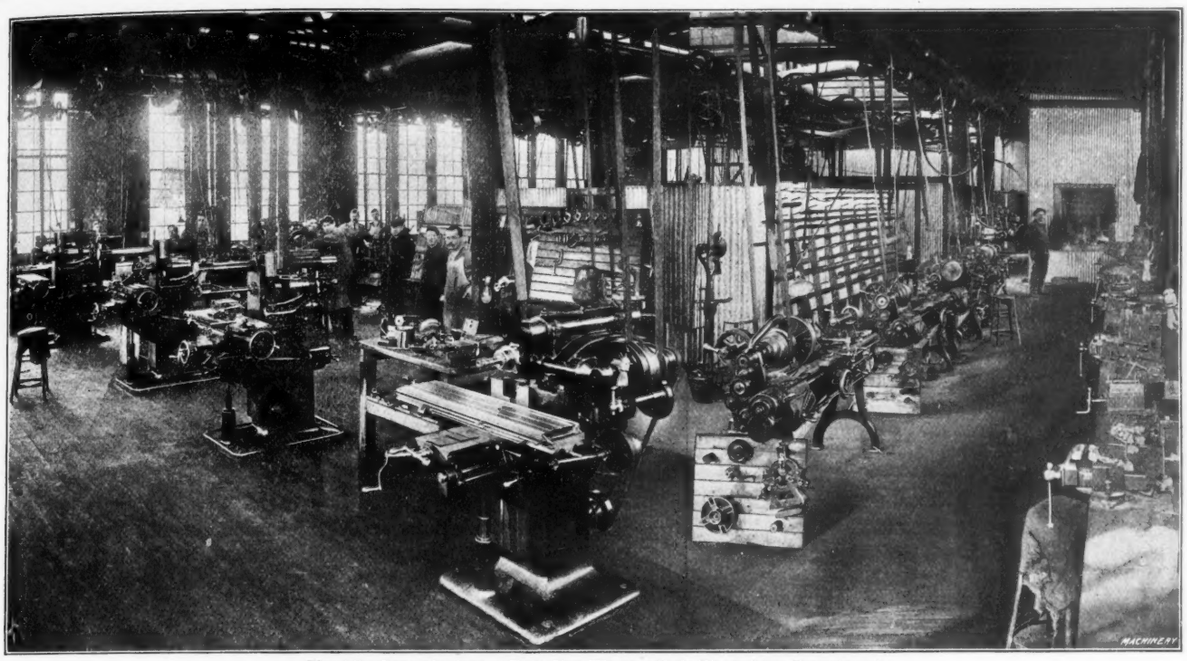

Fig. 16. General View of E. B. Van Wagner Co.'s Die-making Department

which are necessary in making the mold. The first and most important step is the proper planning of the die. Before any work at all can be done, it is necessary to plan the die, *i.e.*, to decide just where the parting lines will come; just what method will be used for ejecting the piece; what alloy will be used; where the casting will be gated; and a hundred and one minor points, all of which have a direct bearing upon the performance of the finished dies. All these decisions have to

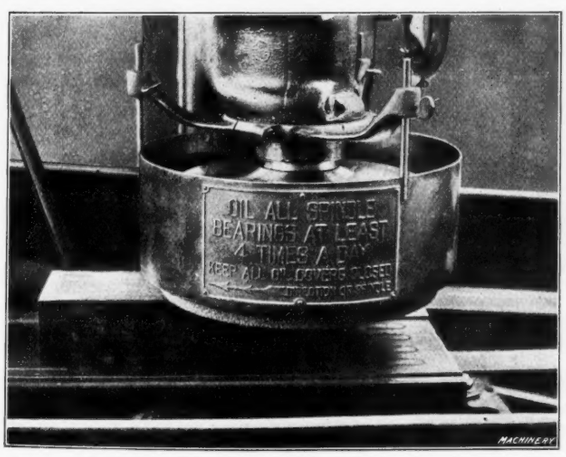

Fig. 17. First Step in making the Mold—Grinding Surfaces of Blocks

be made by the diemaker, and in Fig. 21 he is shown, micrometer in hand, computing the shrinkage allowances that he will make in the dies. This is a very important factor on accurate work as the shrinkage varies from 0.001 to 0.004 inch, according to the alloy and the general shape of the piece.

Before taking up the actual machining operations of the mold-making as conducted in this factory, it will be well to take a typical die-casting mold and note its general construction. Fig. 20 shows a typical die-casting mold closed, while Fig. 18 shows the same mold disassembled on the bench to show its construction. The piece for which the mold has been made is also shown. Fig. 19 shows a similar die in section. From the three illustrations a good idea of an average die-casting mold can be obtained. Referring to these illustrations, the principal parts of this die are the ejector box *A*, and the ejector plate *B* which is operated by the racks *C*. For operating the ejector plate, the pinion shaft *D* having a handle suitable for turning, is furnished. This, of course, fits into a bored hole in the ejector box, bringing the pinion into mesh with the racks for raising the ejector plate. In the ejector plate are three ejector pins *E* for removing the casting

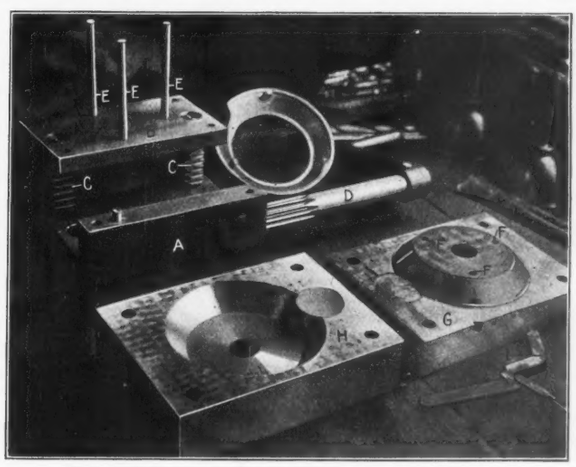

Fig. 18. Die-casting Mold shown in Fig. 20, disassembled

from the mold. The ejector pins operate through holes *F*. Beyond the pinion shaft may be seen the casting for which this mold has been made. It will be noticed that the top side of the casting has three projecting lugs through which are small holes. Provision for forming this side of the die-casting is made in the lower half of the mold *G*, while the upper half of the die-casting is taken care of by the top plate *H*. One of the toggles for operating the core pins through these three

* Associate Editor of MACHINERY.

lugs is shown at *I*. These parts will be described more fully later. The sprue cutter is shown in position in the die at *J*.

Machining the Die Cavities

As will be noticed from Fig. 16, the machinery in the Van Wagner diemaking department is of modern design, for no other class of work demands as good tool equipment and as much skill in the making as die-casting molds. The die-blocks are made of machinery steel. Fig. 17 illustrates the first step in making a die-casting mold after the die-block has been shaped approximately to size. This operation consists in carefully facing off the die surfaces on a vertical-spindle grinding machine. This, of course, is a quick method of surfacing the die-block, and it insures that the top and bottom surfaces of these plates will be parallel, permitting the die-faces to come together properly.

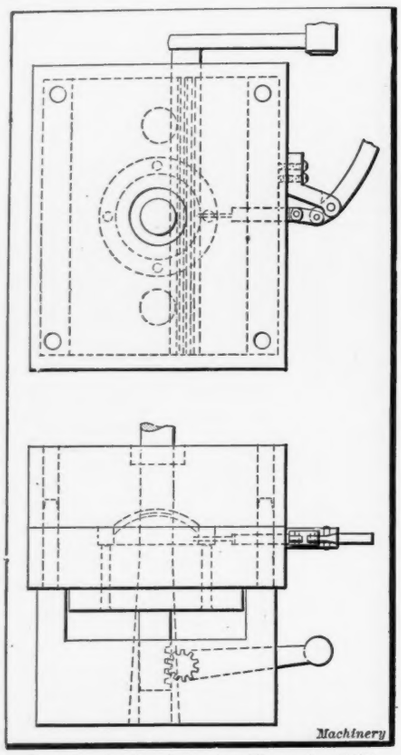

Fig. 19. Section through a Die-casting Mold

The next step consists in laying out the die, as shown in Fig. 22. This is done in the usual manner, by working on a coppered surface, using dividers, scales and a center punch. When laying out the die, the necessary allowances are made for shrinkage and finish, these points having been planned before actual work on the die has been started. As in other phases of die-work, the machining operations are performed, as far as possible, before any hand-work is done. In Fig. 23 may be seen a diemaker turning the cavity in a part of the die-casting mold. The highest type of skilled workmanship is called for on this machine work, and, as may be surmised from Fig. 23, where the diemaker is shown measuring the die with a vernier caliper, the measurements must be exact, for no grinding operations follow the machine work.

Figs. 24 and 26 show typical milling operations being performed on die-casting molds. In Fig. 26 the diemaker is shown indicating a pin in one corner of the mold cavity, preparatory to doing additional milling. The block is held in the usual manner by being clamped on the bed of the milling machine, and after it has been properly located under the cutter head, tools are substituted for the indicator and the milling of the cavity is completed. Fig. 24 shows one of the sections of the die-casting mold which is to be used in producing the casting shown at the right of the work. In this case the diemaker is milling the recess for the steel arbor which may be seen directly in the foreground. This will be fitted in place to provide for the forming of the hole in the side of the piece.

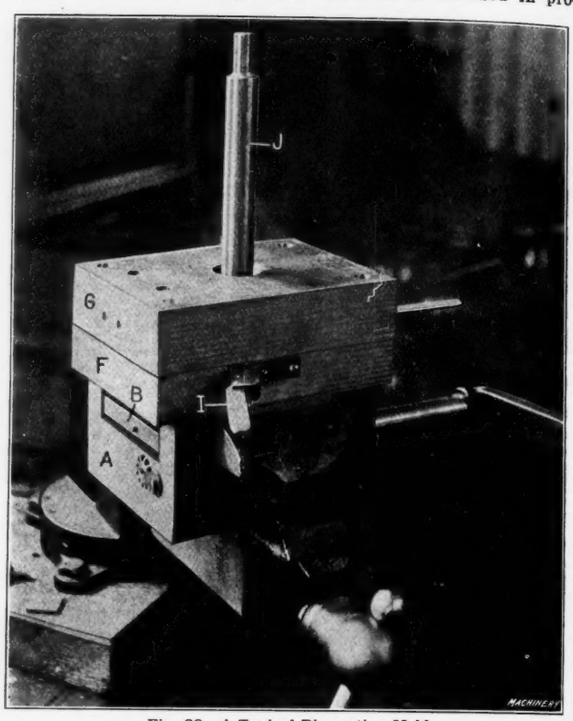

Fig. 20. A Typical Die-casting Mold

Fig. 21. Planning the Die-casting Mold

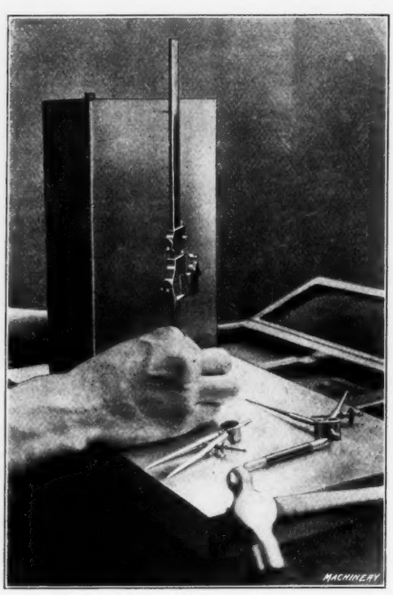

Fig. 22. Laying out One of the Mold Parts

Fig. 23. Turning Out a Die-casting Mold

Fitting the Parts of the Mold

Fig. 27 illustrates several important points in the making of a die-casting mold. This illustration shows the ejector box with the lower half of the mold on it, the ejector plate being

held against the under side of the die-plate by means of the pinion shaft. The operation being done is the drilling of the ejector pin holes. Referring back to Fig. 18, which by the way shows the same die disassembled, the holes being drilled are those shown at *F* for the reception of the pins *E*. The method employed is to drill the holes through the die and into the ejector plate, afterward reaming all holes to size and driving the pins into position in the ejector plate, while they are allowed to slide freely through the die-plate. We will now assume that the ejector box and plate have been completed and fitted, a pinion shaft for operating this plate also fitted, the lower and upper dies completed by the machining operations previously described and all are assembled. The final operation of the fitting of the pins is shown in Fig. 28 in which the diemaker may be seen filing off the ends of these pins so that when dropped to the lower position they will lie flush with the surface. If of uneven lengths, these pins will cause irregular spots in the casting. It now remains to describe the toggles used for operating the cores which form the holes through the three lugs in the casting. One of these toggles, of which there are three, is shown at *I*, in Fig. 20, and also in Fig. 18. These toggles consist of brackets which are attached to the die-plate and levers which are fulcrumed at the ends of the brackets so that their operation works the core pins. It is necessary to remove these core pins after each casting has been made and position them before another casting can be produced.

Fig. 24. A Milling Operation on a Die

The fitting of the parts of a die-casting mold is one of the most important parts of the work. It demands the highest type of workmanship, for a poorly fitted die means a die which works hard in addition to producing poor castings. It is very important that all movable parts should work freely. Fig. 25 shows the assembling operation on a die-casting mold, the casting which is to be duplicated being shown in the immediate foreground. These parts must all be screwed into their respective places, making the joints as nearly air-tight as possible. One cause of poor die-castings arises from the trapping of air in the die, and different methods are employed for overcoming this trouble.

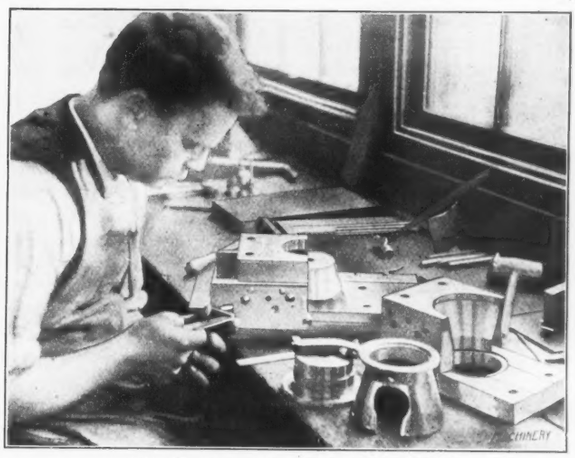

Fig. 25. Assembling a Die-casting Mold

Venting the Dies

There are two methods of preventing air from being trapped in die-casting molds: either by constructing the dies so that the air may be exhausted from the mold cavity before admitting the metal, or by venting the die so that the air may be forced out by the inrushing metal. In the first of these methods it is necessary that the joints in the mold be made as close as possible, otherwise it will be impossible to produce anything like a vacuum in the mold cavity. If, however, it has many parts which must be fitted, it is usually considered advisable to provide the die with vents consisting of milled recesses a

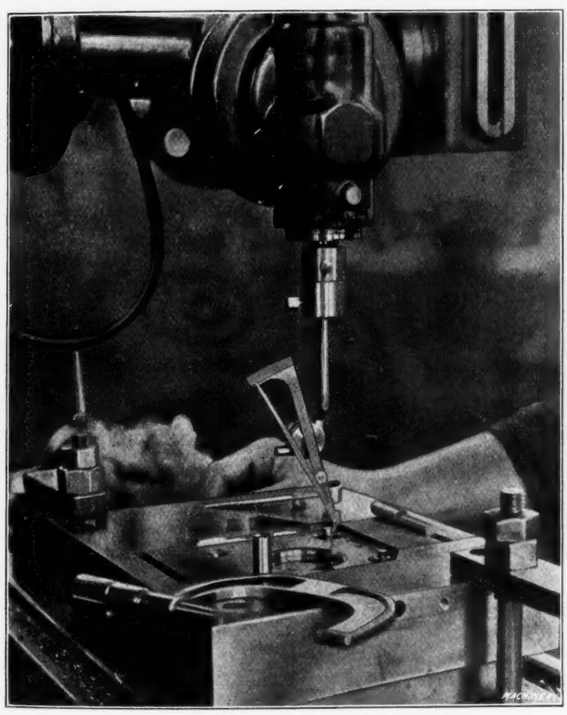

Fig. 26. Indicating a Mold on the Milling Machine

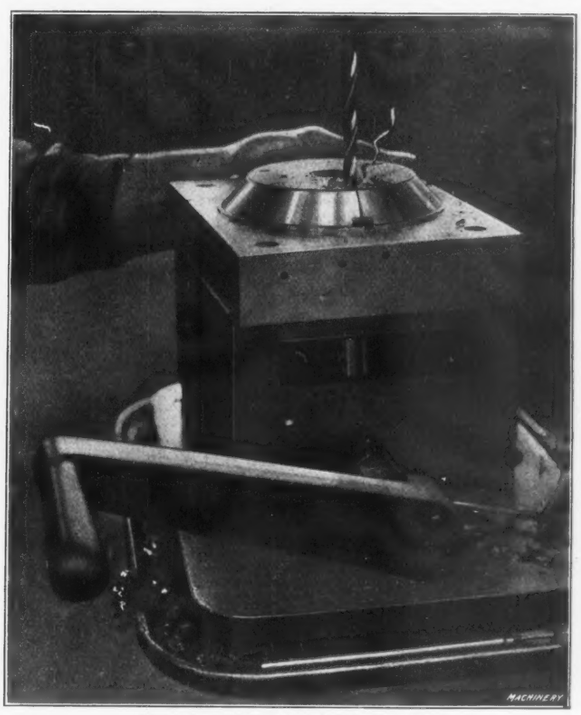

Fig. 27. Drilling the Ejector-pin Holes

few thousandths inch deep. Several vents are provided, from which the air can escape when the metal is admitted to the dies. The hot metal, of course, "shoots" through them in thin ribbons, but not enough escapes to affect the pressure on the metal which goes into the casting.

No matter how carefully a die may have been constructed, nor how carefully it has been assembled, there is always a certain amount of "babying" to be done before it will work satisfactorily. The casting may stick a little here, or there may be a rough spot there, and it is the successful elimination of these troubles which constitutes the production of a good die-casting.

Die-casting Metals

One of the purposes of writing this article is to correct several erroneous impressions which are prevalent in regard to die-casting possibilities. Many people seem to think that nearly all metals can be die-cast, but as a matter of fact, those metals which can be successfully die-cast can be numbered on the fingers of one hand, being alloys of lead, zinc, tin, copper and antimony. The tin base metals shrink very little, while the zinc base metals shrink considerably, although those with a large per cent of aluminum have a very high shrinkage. Without doubt, the most used die-casting metals are the zinc base metals. A typical metal of this class contains about 85 per cent zinc; 8 per cent tin; 4 per cent copper and 3 per cent aluminum. The melting point of this metal is between 800 and 850 F. While this alloy is one of the most common, it is not by any means the best, as there is too little tin employed, but it is a comparatively cheap metal, which probably accounts for its large use. This metal is easily affected by heat and cold, and rapidly deteriorates with age. The Van Wagner Co.

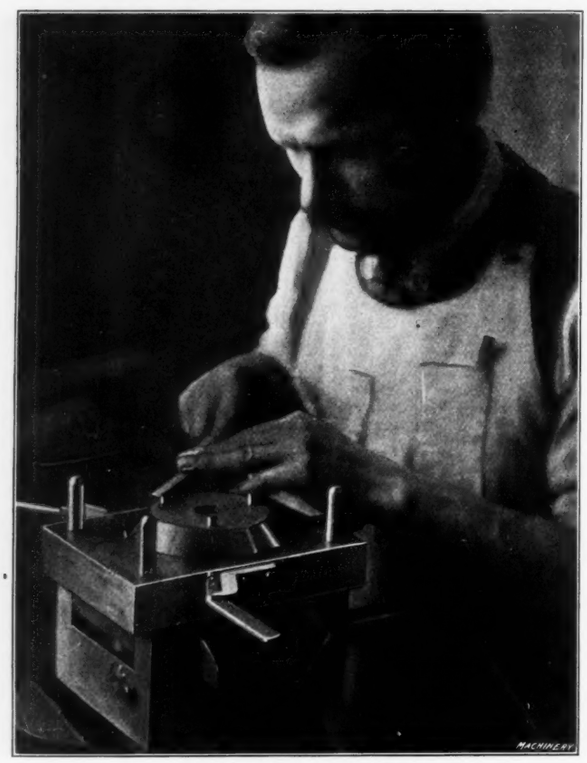

Fig. 28. Fitting Ejector-pins

has a metal similar in composition in which these defects have been reduced to a minimum. The melting point of this metal is from 650 to 675 F. It has a better color and also gives better castings. The lead base metals may be typified by an alloy containing 80 per cent lead; 15 per cent antimony; 4 per cent tin; and 1 per cent copper. This composition melts at approximately 550 F. and it is generally used for castings which receive little wear and where no great strength is required. The weight of this metal is its greatest objection, and it is also quite brittle because of the large percentage of antimony.

For the best class of die-castings, the tin base metals are employed. These range from 60 to 90 per cent tin, and from 2 to 10 per cent copper, together with a little antimony. The melting point of a mixture of this composition is from 650 to 675 F. The castings have a good color and they are much better in quality than any of the other alloys. It is absolutely essential that tin base metals be used for carbureter parts or other parts coming in contact wih gasoline. Also, the tin base metals must be used for parts which come in contact with food products, as the lead or zinc alloys have a contaminating effect. A very successful tin base metal can be furnished by the Van Wagner Co. which contains over 30 per cent tin and still is comparatively low in price. This is a good general metal to use and its corrosive qualities are very low.

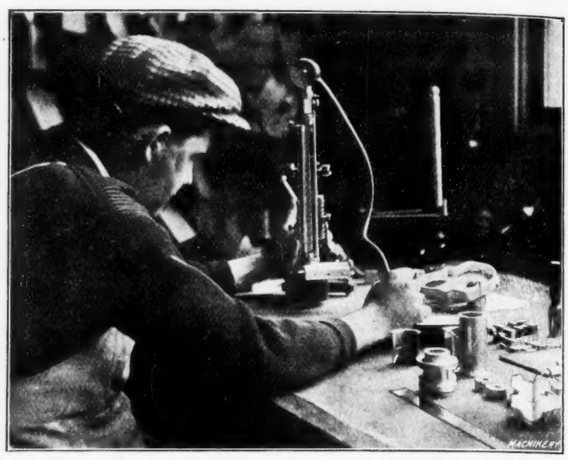

Fig. 29. Inspector using Scleroscope in the Metallurgical Laboratory

Aluminum alloys have been cast in France and Germany in limited quantities, but very seldom in this country on account of their high melting point, as well as their effect upon the dies. After aluminum alloys have been run in the dies for a short time, the surfaces of the molds become pitted. Through some unexplainable cause, the metal seems to flake out particles of the steel in the molds. When an aluminum alloy is to be used, a good mixture is 80 per cent aluminum, 3 per cent copper and 17 per cent zinc. This alloy has a high shrinkage and it has also the same deteriorating effect upon the dies, but to a much less degree than pure aluminum. Fig. 29 shows a corner of the experimental laboratory, in which the inspector is shown subjecting a casting to a scleroscope test. Dies are about to be made for this piece and it is essential to know the comparative hardness of the alloy which should be used in order that the specifications may be taken care of properly. By the use of the scleroscope he is able to get an approximate idea of the hardness of the composition without a chemical analysis, and by comparing this reading with that of a casting of known composition can come very close to the mixture to be used. With this knowledge in hand, he can confer with the diemaker, telling him just what shrinkage may be expected from the alloy.

On the subject of die-casting alloys, as well as many other points of the business, a modern die-casting company can render great service to its customers. Oftentimes, by consultation, an alloy can be selected which will serve all the purposes required at a low cost, and likewise a die-casting proposition can be made far more economical by following some of the recommendations given when designing the piece. It will thus be seen that it is for the mutual advantage of the die-casting user and manufacturer to work in harmony.

* * *

The fire department of Brunswick, Germany, has made exhaustive experiments with calcium carbide to ascertain the practicability of using this material for thawing out frozen pipes and water hydrants. The carbide is sprinkled upon the snow or ice-covered pipes and hydrants and the gas evolved is lighted. It is stated that one of the hydrants that was frozen exceptionally hard, and besides was covered with a very thick coat of ice, was thawed out in 15 minutes. The method, however, is combined with certain elements of danger and should not be employed by inexperienced persons.

TWO DRILL JIG ATTACHMENTS

BY CHRISTIAN F. MEYER*

Fig. 1 shows a drill jig *A* with a cast-iron frame *B* set in it. The latter is only partially shown, since the missing part is foreign to the purpose of this article. The frame *B* has a number of finished surfaces *S*, and a large number of drilled holes which are not shown. The finishing of these surfaces and the drilling of all holes is performed in the same jig. It is necessary, however, to perform two other operations before the frame is ready to be placed in this jig. The first operation is to finish the two locating surfaces *Q* in such a way that both finished sides of each of them—shown by dotted lines

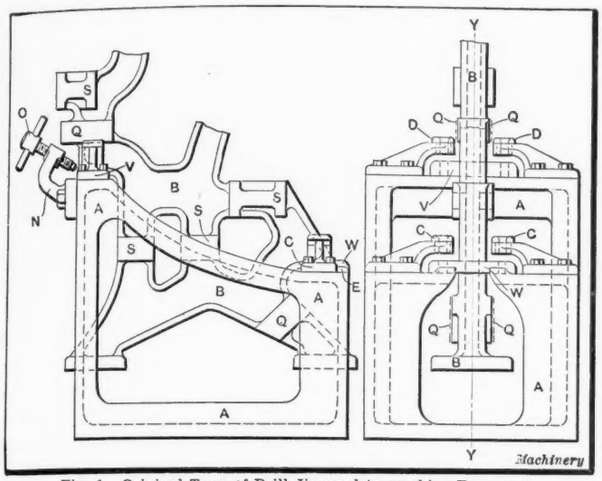

Fig. 1. Original Type of Drill Jig used to machine Frames A

in the side view—are at exactly the same distance from the center line *Y-Y*. The bottoms of flanges *V* and *W* are finished at the same time. These guiding surfaces serve to locate the frame accurately in the jig for the final operations. Two holes in each of the flanges *V* and *W* must also be drilled before the frame is ready for the last operations, the jig shown in Fig. 1 being designed for this purpose. The frame is lifted into the jig by means of an opening left in the right side for that purpose. It is then placed in position with flanges *V* and *W* under the drill guides *D* and *C*, respectively. As the accuracy of the entire frame depends upon the correct location

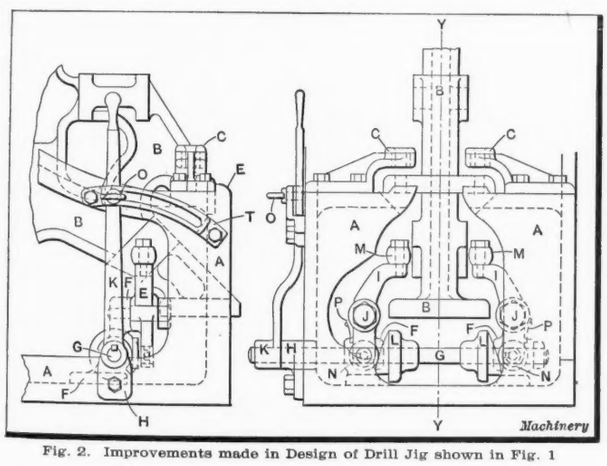

Fig. 2. Improvements made in Design of Drill Jig shown in Fig. 1

of these guide holes, the center-line of the frame should be exactly on the center-line between the drill guides before the holes are drilled. When the operation was performed by the old method, the frame was set by means of a soft hammer, the distance from the finished sides *Q* to the center-line of the respective drill guide being measured at frequent intervals. The frame was then fastened by means of bracket *N* and hardened screw *O*, which would press it against stops *E*. Almost invariably, the tightening of these screws would throw the frame out of alignment again. Since the frames weigh 200 pounds, they are very difficult to handle and to set, and it can be readily understood that the work turned out by this jig was inaccurate and took a long time to produce.

As large quantities of these frames were used, it was decided to change the entire process of manufacturing them, even though a considerable outlay was involved. Then the writer of this article constructed two little attachments by means of which the jig is enabled to give excellent results. The attachment for the right side of the jig is shown in Fig. 2. It consists of two brackets *F* fastened to the bottom of the jig at both sides of the center-line. Each of these brackets is provided with a lever *I* swinging around a suitable stud *J*. Each lever has an upper roller *M* and a lower roller *N*. Rollers *N* work against two cams *L* which are fastened upon a shaft *G*, the latter being supported by suitable bores in brackets *F*. The upper rollers of levers *I* work against the finished locating surfaces of the frame *A*. The outer end of shaft *G* is supported by the bearing *H* and is provided with a lever *K*. The latter works in a slotted guide *T* and may be held in any position by means of a screw and nut *O*. Flat springs *P* always press lower roller *N* of levers *I* against cams *L*. The latter may be adjusted on shaft *G* in such a way that their turning will always keep the rollers *M* at exactly the same distance from the center-line *Y-Y*.

The second attachment at the left side of the jig is shown in Fig. 3. It consists of a cast-iron bracket *Z* fastened in place of the old bracket *N* of Fig. 1. A cast-iron lever *P* swings within *Z* on the pin *R*. Lever *P* is provided with a small hardened

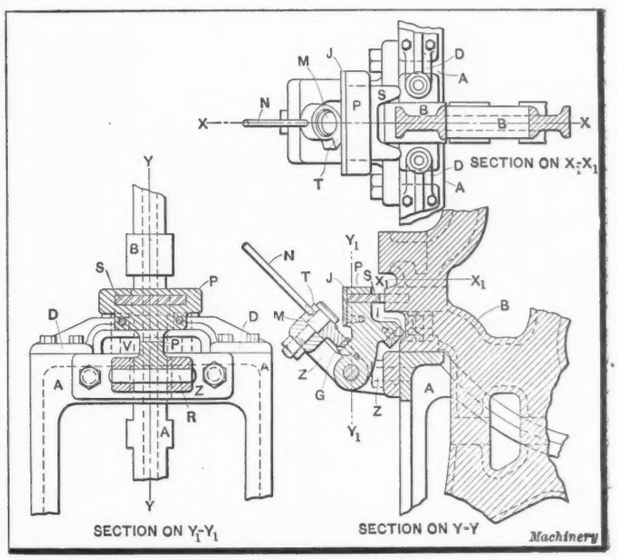

Fig. 3. Detail of Mechanism used to secure the Required Sidewise Adjustment

steel plate *I*, which works against flange *V* of frame *A*. The upper part of lever *P* is provided with a slot in which the guide piece *S* is a sliding fit. The latter has a V-shaped cut-out in front and is fastened in the lever in such a way that the center-line *X-X* coincides exactly with the middle line between the centers of the drill-guides, or with the center-line *Y-Y* of frame *A*. The backward motion of guide piece *S* is limited by a strong spring *J*, the lower end of which is held by two flat head screws, while the upper part is free to swing out. The extension of bracket *Z* holds a steel cam piece *T* by means of stud *M*. The cam piece *T* is turned by handle *N* and engages with a hardened steel plate *G* fastened to lever *P*, thus pressing the steel plate *I* against the flange of the frame. The operator lifts the frame into the jig as before. He next throws over lever *K* (Fig. 2) and the rollers *M*, working against the finished locating surfaces, bring the right side of the frame into exact position. The locking of screw *O* will also hold lever *K*, and consequently frame *A*, in this position, while the rollers *M* permit an easy forward movement against stops *E*. The cam piece *T* is now turned and presses lever *P* forward. Guide piece *S* engages the locating surfaces of frame *A*, thus pushing the latter exactly into line. As soon as *A* has come up against stops *E*, the guide piece *S* will press back spring *J* and so allow lever *P* to tighten frame *A* to any

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desired degree. Another feature of the improved jig is that a small strip of metal is cut away to an angle of 45 degrees right in front of stops *E*, as shown in Fig. 2. This allows the chips to fall away and makes the stops of the jig self-cleaning. It will be seen that by means of these attachments every frame is brought into exact position and held there very simply. The efficiency of the jig has increased 500 per cent and every frame is now a sample of accuracy.

* * *

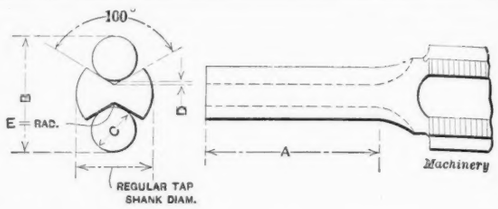
SPECIAL SHANKS FOR TAPS

When tools for special holders or chucks—such as the Beaman & Smith or the Graham—are to be made, it is often the custom to send a sample along with the order on account of the fact that tables giving dimensions for these shanks are not readily available. This not only causes delay and inconvenience, but sometimes is the cause of a gradual loss of the original sizes or standards. Hence, a table has been compiled applying to taps with shanks which fit the Beaman & Smith and Graham special chucks or holders, these two being the most used of the special chucks with which the writer has had experience. The tables as made up for the Beaman & Smith holders are applied to hand taps, but it is, of course, obvious that tools of any kind, which are suitable to be used in these holders, can be made with shanks of the same dimensions as here recorded. The three different styles of taps referred to in the tables are those with the shank smaller, equal, or larger in diameter than the threaded portion of the tap, as indicated in the engravings.

Besides hand taps, regular Briggs' standard pipe taps are frequently made with shanks to fit the Beaman & Smith holders. When this is the case, taps of ⅛ and ¼ inch nominal size generally fit the No. 1 holder; taps from ⅜ to ¾ inch nominal size are made to fit the No. 2 holder; taps from 1 to 1½ inch nominal size are made to fit the No. 2½ holder; and taps from 2 to 3 inches nominal size are made to fit the No. 3 holder. The length of the shank, of course, is made long enough to allow some clearance between the end of the slot cut in the shank and the threaded portion of the tap. The slot, the length of which is given as *G* in Tables I and II, should be flat or parallel in the bottom for a length equal to that dimension.

The Graham chuck shanks are used also to a considerable extent on drills. Table III gives the dimensions for the grooves in the shanks, and the size of taps for which the different sizes of shanks are to be used. The tap should, of course, be so proportioned that the total length of the shank is slightly greater than the dimension *A*.

TABLE III. DIMENSIONS OF TAP SHANKS TO FIT GRAHAM CHUCKS

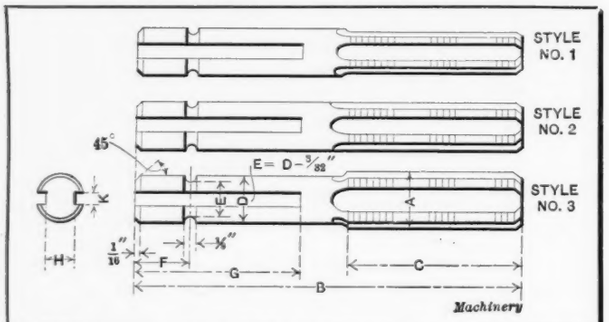


No. of Shank	Sizes of Hand Taps Used for	Sizes of Pipe Taps Used for	A	B	C	D	E
1	¼″ to 15/16″	⅜″ to ½″	1⅝	0.710	¼	0.0206	1/64
2	1″ to 2½″	¾″ to 3″	2½	1.713	⅜	0.0402	1/32

* * *

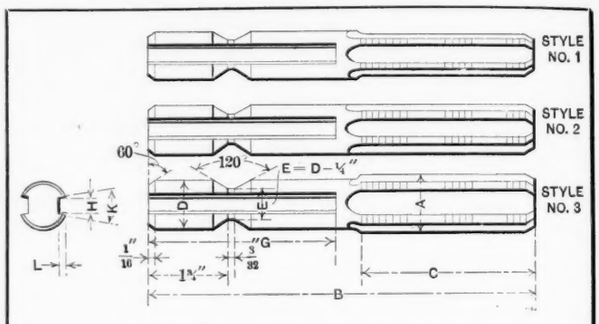
The cost of workmen's compensation, as arranged under the British compensation act, appears to be insignificant as compared with the great benefits resulting in that disabled working men are not thrown upon the community or charity for relief, but are, so to speak, maintained by the industry responsible for their injuries. According to the returns for 1911, for example, in the coal mining industries, where the compensation charges range higher than in any other industry in Great Britain, the cost due to the working of the act is only 2.2 cents per ton of coal mined. The average payment in case of death was $770 and for temporary injuries, $20.

TABLE I. HAND TAPS FOR NOS. 1 AND 2 BEAMAN & SMITH HOLDERS



No. of Holder	Diameter of Tap A	Total Length B	Length of Thread C	Diameter of Shank D	Center of Groove from End F	Length of Slot G	H Max.	H Min.	K Max.	K Min.	Style of Tap, No.
No. 1 Holder	1/4	2 3/4	1	13/64	13/64	1 1/16	0.24	0.22	0.12	0.11	1
	5/16	3	1 1/4	13/64	13/64	1 1/16	0.24	0.22	0.12	0.11	1
	3/8	3 1/2	1 1/4	13/64	13/64	1 1/16	0.24	0.22	0.12	0.11	2
	7/16	3 1/2	1 5/8	1/4	13/64	1 5/16	0.36	0.34	0.13	0.12	1
	1/2	3 3/4	1 1/2	1/4	13/64	1 5/16	0.36	0.34	0.13	0.12	2
	9/16	4	1 5/8	1/4	13/64	1 5/16	0.36	0.34	0.13	0.12	3
	5/8	4	1 5/8	1/4	13/64	1 5/16	0.36	0.34	0.13	0.12	3
No. 2 Holder	11/16	4 1/2	1 7/8	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	1
	3/4	4 7/16	2	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	2
	13/16	4 3/4	2 1/8	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	3
	7/8	5 1/16	2 1/4	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	3
	15/16	5 1/8	2 3/8	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	3
	1	5 1/16	2 1/8	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	3
	1 1/16	5 1/16	2 1/2	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	3
	1 1/8	6	2 5/8	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	3
	1 3/16	6	2 5/8	5/16	13/64	1 3/8	0.54	0.52	0.21	0.20	3

TABLE II. HAND TAPS FOR NOS. 2 1-2 AND 3 BEAMAN & SMITH HOLDERS

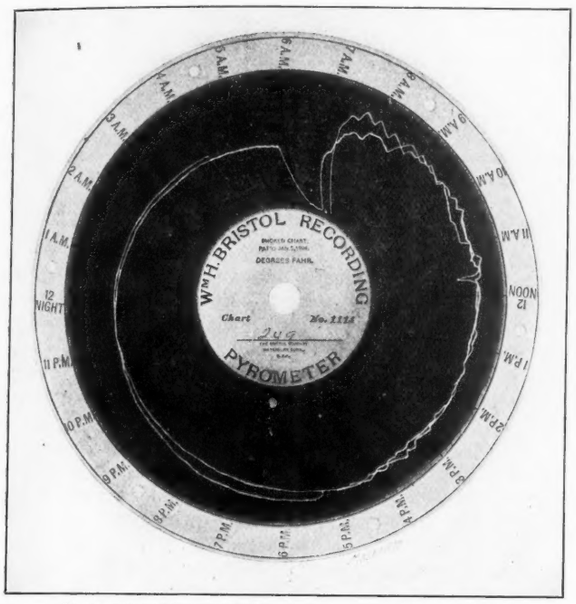


No. of Holder	Diameter of Tap A	Total Length B	Length of Thread C	Diameter of Shank D	Length of Slot G	Width in Bottom of Slot H	Angle of Sides of Slot, Degrees K	Depth of Slot L	Style of Tap, No.
No. 2½ Holder	1	6 3/4	2 1/2	1 1/8	2 1/4	1/4	20	3/16	1
	1 1/16	6 1/4	2 1/2	1 1/2	2 1/4	1/4	20	3/16	1
	1 1/8	6 3/4	2 1/2	1 1/2	2 1/4	1/4	20	3/16	1
	1 3/16	6 3/4	2 1/2	1 1/2	2 1/4	1/4	20	3/16	1
	1 1/4	7	2 5/8	1 1/2	2 1/4	1/4	20	3/16	1
	1 5/16	7	2 5/8	1 1/2	2 1/4	1/4	20	3/16	1
	1 3/8	7 1/4	2 3/4	1 1/2	2 1/4	1/4	20	3/16	1
	1 1/2	7 1/2	2 3/4	1 1/2	2 1/4	1/4	20	3/16	2
	1 5/8	7 3/4	3	1 1/2	2 1/4	1/4	20	3/16	3
	1 3/4	8	3 1/8	1 1/2	2 1/4	1/4	20	3/16	3
	1 7/8	8 1/4	3 1/4	1 1/2	2 1/4	1/4	20	3/16	3
	2	8 1/2	3 3/8	1 1/2	2 1/4	1/4	20	3/16	3
No. 3 Holder	2 1/8	9	3 1/2	2	3	5/16	16	7/32	3
	2 1/4	9 1/4	3 5/8	2	3	5/16	16	7/32	3
	2 3/8	9 1/2	3 3/4	2	3	5/16	16	7/32	3
	2 1/2	9 3/4	3 7/8	2	3	5/16	16	7/32	3

ANNEALING HIGH-SPEED STEEL

BY E. D. A.

The writer takes exception to the article by "A" in the December number under the title "Annealing High-Speed Steel." The method referred to as being the one most generally used for annealing high-speed steel is incorrect, in that the temperatures 1900 to 1950 degrees F. are very much too high. Also, the time in heating, of from nine to ten hours, is incorrect, and further, air-slacked lime is only used occasionally for a packing medium; the practice of using pulverized or powdered charcoal to pack the pieces of steel to be annealed is very much more common. The following method is recommended by one of the largest high-speed tool steel manufacturers in America. The writer has compared this method with the methods recommended by other manufacturers and finds that they are precisely the same in all the important points. Particular attention is called to the temperatures to which the steel to be annealed is to be heated, the time necessary, and also, that powdered charcoal is given first, it having the preference over fine air-dried lime or powdered mica.



Temperature Record obtained from an Annealing Furnace

"In annealing high-speed steel, use an iron box or pipe of sufficient size to allow at least one-half inch of packing between the pieces of steel to be annealed and the sides of the box or pipe. (We call attention here to the fact that it is not necessary that each piece of steel to be annealed be kept separate from every other piece, but only that the steel be prevented from touching the sides of the annealing pipe or box.) Pack carefully with powdered charcoal, fine dry lime or mica. Cover with cap, which should be air tight, but if it is not, then lute on with fire-clay. Heat slowly to a full red heat, about 1475 or 1500 degrees F., and hold at this heat from two to eight hours, depending on the size of the pieces to be annealed. A piece of 2 by 1 by 8 inches requires about three hours time. Cool as slowly as possible, and do not expose to the air until cold. A good way is to allow the box or pipe to remain in the furnace until cold."

A series of experiments was recently made by the writer to determine the proper temperature to which to heat high-speed steel for annealing. It was found that when this steel was heated to below 1250 degrees F. and slowly cooled, as in annealing, it retained the original hardness and brittleness imparted to the steel in forging. When heated to between 1250 and 1450 degrees F., the Brinnell test indicated that the steel was soft, but impact tests proved that the steel still retained its original brittleness. However, when heated to between 1475 and 1525 degrees F. the steel became very soft, it had a beautiful fine-grained fracture, and all of the initial brittleness had entirely disappeared.

In carrying these tests further, to 1600, 1750, and 1850 degrees F., it was found that the steel became very soft, but there was a gradual increase in brittleness and in the size of the grain, until at 1850 degrees F. the steel became again as brittle as unannealed steel; the fracture at this temperature was dull, dry and lifeless, and showed marked decarbonization. Dried air-slacked lime was used as a packing medium in making these tests. The steel was packed in tubes sealed air-tight on both ends. The decarbonization that took place was probably due to the oxygen in the air that had filled the intervening spaces between each minute particle of lime, before it was packed in the tube, attacking the carbon of the steel; this decarbonization would not have taken place if powdered charcoal had been used. The latter would have supplied all the carbon necessary to combine with any oxygen present in the tubes.

The new method described by "A" would be very impractical in that the tools to be annealed are not packed in any medium. Persons acquainted with the heating of tool steel know that all grades of steel when heated to only 1250 degrees F. in the air, begin to scale, due to the oxygen of the air attacking the carbon of the steel. If a piece of steel were heated for even one hour to 1700 or 1750 degrees F., the scale formed would be from seven to ten per cent, in weight, of the total weight of the original piece. This amount of scale would ruin any steel. At the same time there would be a decarbonization extending below the zone of the scale to a depth of fully 1/32 inch. If it were required to subsequently harden such a piece of steel, all of this decarbonized surface would have to be removed before the steel could be hardened by any ordinary methods.

By permission, an annealing chart, taken by a Bristol recording pyrometer, showing the temperature of one of the annealing furnaces in which a well-known grade of high-speed steel is annealed by the manufacturer, is shown in the accompanying illustration. The method, which is carried on by this manufacturer day after day, is to first pack the bars to be annealed in ten-inch diameter wrought iron pipes, about fourteen feet long, the packing medium being pulverized charcoal. Then both ends of the pipes are sealed air-tight with fire-clay. The annealing furnaces are fired with coal and are brought up to 1500 degrees F. at 7 A. M. At this time the large furnace doors are opened and from four to six of the ten-inch pipes, previously packed with steel and sealed, are rolled into the furnace. The doors are then closed and the furnace is continuously fired until 5.30 P. M., the temperature being kept as near to 1500 degrees F. as possible. The chart, which shows two days work, will indicate how well this temperature has been maintained. At 5.30 P. M. firing is discontinued, all holes that might permit the influx of air are closed, and the pipes are permitted to cool down slowly with the furnace. It will be seen, by again referring to the chart, that there is a gradual drop in temperature from the time firing is discontinued until the pipes are taken from the furnace the following morning preparatory to beginning another day's work.

The chart also indicates that the temperature of the annealed steel, when taken from the furnace, is about 1000 degrees F. This temperature is several hundred degrees below the critical point, or recalescence point of high-speed steel, this point being at about 1350 degrees F., so that the annealed bars can be taken from the pipes and permitted to cool to normal temperature without further delay, because after cooling to 1000 degrees F. they would not again become hard without the application of more heat.

The above method is excellent for annealing high-speed steel on a large scale. If it is desired to anneal only a few small pieces of this grade of steel rapidly, they can be "water annealed," by a method similar to that used for carbon steels; the temperature to which the steel is raised, however, is not as high as for carbon steel. In water annealing, the piece to be annealed is gradually and uniformly heated to 760 degrees F. It is then taken from the furnace and plunged into a bath of pure water, previously heated to a temperature of 150 degrees F., where it is permitted to cool until reduced to the temperature of the bath. Afterwards the steel can be drilled, filed, or machined into any form with little difficulty. The more care devoted to the heating, the better the results will be. To heat rapidly will induce internal strains and greatly increase the risk of breakage when the pieces are plunged into the water bath.

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FEBRUARY, 1913

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TWIST DRILL GRINDING

The drilling machine is the most common machine tool in use. Hundreds of plants that have no machine shop have one or more drilling machines for use on repair jobs and other emergency work. In many cases they are operated by unskilled labor, and the drills are ground to all sorts of shapes and angles, few approximating the best form for efficiently cutting metal away to make smooth holes, true to drill size. It may be safely asserted that drills are the most common form of metal cutting tools and also the most abused.

But the neglect and abuse of drills, particularly twist drills, is by no means confined to those situations where unskilled labor is employed for operating drilling machines. Notwithstanding the attention that has been given to the development of cutting tools in the last decade, the drill has been badly neglected. Large plants are in operation using many drilling machines in which practically all the drills are ground by hand. The result is general inefficiency. Drills are broken needlessly, power is wasted and poor work is produced.

Twist drill grinders have greatly improved the conditions where used, but the idea still lingers in the minds of some workmen that they can grind a twist drill by hand better and quicker than on a machine. The notion is a mistaken one. While it is true that an expert can grind a twist drill so that it will cut efficiently, the average operator cannot or will not. Nothing is more common in plants in which the workmen are permitted to grind drills by hand than to find drills dragging on the heel, angles too pointed and other glaring defects that operate against efficient drilling.

More attention should be given to the problem of maintaining drills and drilling machines in first-class condition. Drills and power will be conserved, better work will be produced, and twist drill manufacturers would be spared many complaints as to the poor quality of their product.

* * *

ORDERLINESS IN SHOPS

A clean and orderly manufacturing plant, noted for the high grade of its output, does not produce first-class goods simply because good "housekeeping" is a characteristic of its management, but high-grade machines are generally made where orderly conditions prevail. In workrooms that are dark and dingy dirt is likely to collect on the floor, in corners and on the walls. Tools are left to encumber the floors and machines. Chips pile up and oil soaks the floor. The result is confusion, and the tendency is for the workmen to become slovenly.

Plenty of light shows the disorder, and well-lighted shops are generally clean shops. Light, cleanliness and order go hand in hand. Of course dark shops can be kept clean and orderly: the jigs and fixtures can be kept in the tool-room when not in use, chips can be kept off the floor, and old belts can be carried to the junk room; but more force of management is needed to accomplish these results. Let the light in, and every well-trained man will be ashamed to make unnecessary dirt and litter. A light shop and a clean shop are synonymous.

* * *

SPECIALISTS WHO DO NOT SPECIALIZE IN PRICES

One of the peculiarities of manufacturing in this era of specialization is the fact that specialization in some cases is more apparent than real. Specialized manufacture that does not produce goods for the market at lower prices than the cost of making them without special equipment is a pretense. Take the manufacture of ball and roller bearings as an example. Several concerns make these exclusively, and presumably are well equipped to produce everything in anti-friction bearings needed by machine manufacturers at prices lower than they can be produced in a plant doing a large variety of work. Nevertheless, ball and roller bearings are being made by machine tool builders and other machinery manufacturers for use in their products. Makers of motorcycles make their own roller bearings, using for the most part standard machine tools equipped with a few special jigs and fixtures. It seems very undesirable to complicate the manufacture of a complex machine by making the roller bearings. Why is it necessary? Simply because the bearings can be made exactly as wanted and at lower cost than that at which they can be bought from the specialists.

Is the cost of selling ball and roller bearings so high that the advantages incident to specialized manufacture are lost when the maker comes into competition with a manufacturer who uses the product in sufficient quantity to become a competitor? This question is one that needs the attention of those specialists who apparently don't specialize except for customers who cannot produce for themselves.

* * *

RED TAPE IN MANUFACTURING ORGANIZATIONS

The larger an organization is, the more likely are its activities to be hampered by circumlocution. The purchasing agent stands between the manufacturer and the heads of the departments which requisition his product. When the product is of standardized nature which can be treated like shelf hardware, shovels, sugar or cotton cloth, no particular harm results perhaps, when a specific make of goods is not ordered; but in the case of specialized machinery requiring skilled attendance and perhaps a certain degree of adaptation to the work on which it is to be employed, the situation is different.

The makers of certain classes of machine tools find their efforts greatly hampered in dealing with large corporations when they attempt to render special service. The head of a department may know exactly what he wants and may be a very desirable customer, but when his requisition must pass through the hands of a cold, unsympathetic purchasing agent having little appreciation of the conditions to be met and the need of personal conference of the interested persons, then dissatisfaction is likely to ensue.

Large corporations are at serious disadvantage when compared with small concerns in this respect, and perhaps this and other factors limiting expansion are fortunate for the well-being of the smaller firms; but in some businesses, especially that of transportation, which are necessarily large, improved methods of transacting business are badly needed. The improvement required is simplification of the method of buying and the injection of common sense. When buyer and seller should meet on common ground to discuss the special requirements of a given case the opportunity should be afforded.

METHODS OF OILING MACHINE TOOLS

The article by Mr. Horner on methods of oiling machine tools, begun in another part of this number, illustrates a large number of oiling devices, more or less conventional, many of which are in common use or have been employed on machine tools and other machinery. The review undoubtedly will be found of interest and value by mechanics and machine designers generally. Among the large number of oiling devices shown, some few must be better than all of the others for general purposes. The question of determining which are the best may not be easy to answer when the factors of first cost, ease of application, convenience of use and reliability of action are all considered. In view of the importance of lubrication generally, especially of high-speed machinery, every reader will find it well worth while to study these oiling devices, and weigh their respective advantages and disadvantages.

While considering the relative merits of the conventional designs, we should not lose sight of the fact that individual oil holes which are supplied by the operator from squirt-cans, are likely to become obsolete in the near future. High-grade machine tools and machinery generally will soon be self-oiling in the sense that the machines will automatically distribute oil from a central receiver to all their principal bearings. For this reason, perhaps the choice of the best device will necessarily be a flooded lubrication system, one example of which is shown.

* * *

PROCESSES FOR WORKING AND SEPARATING MATERIALS

The development of automatic machinery for working cloth, tissue, paper, fibrous materials, hair, bristles, etc., often requires ingenuity of a higher order than for working metals or other materials of firm constituency. Sheet metal, for instance, can be depended on to hold a definite shape irrespective of the influence of gravity or air currents. It can be grasped by jaws or fingers and can be pushed or pulled. Cloth in sheets can be fed readily, but when cut up into small pieces it becomes unmanageable with ordinary appliances. Paper, likewise, is capable of being easily handled in continuous rolls, but offers difficulties when cut into sheets or small pieces. Compressed air is used to separate sheets for feeding to printing presses, and fingers terminating in suckers or vacuum cups are successfully employed to handle small pieces of paper. Fibrous materials, tobacco, shredded wood, steel wool, cotton, waste, etc., offer peculiar difficulties when separating into small lots of definite weight. Feeding and cutting devices cannot be used in some cases because of damage to the fibers or because the sharp raw edges are not permissible. To divide steel wool into pound lots and pack it into cartons, for example, is a problem of no small difficulty. The material collects in irregular masses in the process of manufacture, and it cannot be cut apart to use for the purpose intended without damage. To wrap crackers in neat boxes is another problem which has been solved and for which there were few precedents.

In the separation of certain natural products, advantage is often taken of structural peculiarities. Bristles used for paint brushes must all be arranged with the "flag" ends the same way. To do this by picking them apart by hand and turning around "end to end" is out of the question, and it is hardly practicable to design a machine that would accomplish the proper arrangement by any of the common selective processes. But the fact that hair and bristles have surfaces covered with hooked scales all pointing toward the flag or outer end, enables the separation by a simple operation to be quickly and easily accomplished. A bunch of disarranged bristles will separate longitudinally when rolled back and forth between the hand and a table, the individual bristles moving butt end ahead. A few passes back and forth suffices to separate them into two groups, each group having the butts together. These can then be readily picked up and laid together with the butts and flags together.

Each material to be worked must be studied, and some individual peculiarity seized on to make it follow the course required. That method which will work well with one may be impracticable with another. Vacuum cups, of course, cannot be used on ordinary cloth as effectively as on paper. Gravity may be effective in one case and ineffective in another. Shaking or rocking motions which separate straight pins from crooked ones will not work on other shapes. Magnets which effectually pick out bits of steel and iron from grain are ineffective on stones. Hence a variety of means may be employed for cleaning a material. For example, in the cleaning of grain, advantage is taken of air currents, specific gravity, inertia, shape, size, elasticity, magnetic induction, etc.

* * *

THE VALUE OF A UNIFORM ACCOUNTING SYSTEM

The marked tendency of business in the last decade has been in the direction of eliminating competition by effecting combinations of competing concerns or making agreements which insure stability of trade. That these combinations have been made the cloaks for monopoly, restraint of trade and various nefarious practices distinctly illegal, has been only too apparent. The tendency to combine has been checked by the enforcement of the Sherman anti-trust law, but men having come to a realization of the wastefulness of unintelligent competition, are still seeking to eliminate such competition wherever possible, through cooperation.

Ruinous and foolish competition often results from manufacturers not knowing what their product actually costs to produce. Owing to this common ignorance, many products are under-priced or over-priced, especially when they are part of a large line of manufactured goods. If the manufacturer always knew exactly what it cost to produce each article, he would not be likely to place an article in competition with another, at a price below its actual cost of production.

Working on this assumption, some manufacturers are endeavoring to bring about the adoption of uniform systems of accounting in their respective trades, believing that the adoption of uniform cost systems will tend to eliminate destructive competition. Under the various systems of cost accounting now in use, there is often a lack of definite knowledge as to the cost of repair parts, or machines and other products built as part of a line. The cost systems are frequently defective, and the aim is to eliminate the faulty systems and bring about the adoption of certain principles of accounting which will provide manufacturers in competing lines with essentially the same system of costs. They will, it is argued, be more likely to place rational prices on their products.

The value of a uniform accounting system can hardly be overestimated. It would open the eyes of many manufacturers to losses hitherto unsuspected, and present the cold facts as to losses incurred in striving to outdo the other fellow by cutting prices. If prices are cut below actual manufacturing costs, the loss is plainly apparent, whereas some systems of cost accounting now in use are so irrational that the actual condition does not become apparent until heavy losses have been sustained.

* * *

As concrete floors have come into use, certain faults have developed. One of the most common objections is that of the men who complain that a concrete floor is "hard on the feet." A concrete floor is no "harder" to stand on all day than a wooden floor, but it is a much better conductor of heat, and it is now generally known that the tiring, chilling sensation of the concrete floor is due to its comparatively low temperature and high heat conductivity. When the floor is warmed, the "hardness" on the men's feet disappears. But another and real hardness remains which is of serious importance to manufacturers, especially those whose product includes many small cast-iron parts. It has been found that breakages are greatly increased. A casting dropping on a wooden floor from a lathe is seldom injured, but if it drops onto concrete it is very likely to fracture. Some machine builders have noted a very serious increase of casting breakages from this cause alone, and for this reason concrete is objectionable for machine shop floors, especially for light work.

FIXTURES FOR MACHINING EXHAUST PIPES

BY W. L. MYLES*

The following illustrations show a number of special fixtures which are used in one of the large gasoline engine manufacturing plants for machining a new style of exhaust

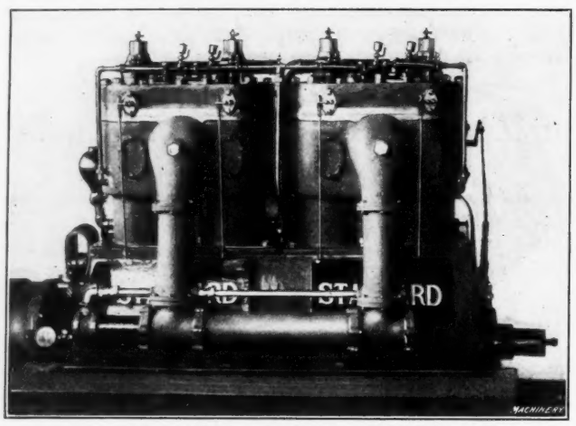

Fig. 1. View of Engine showing Assembled Exhaust Pipe

pipe. These pipes are of the water jacketed flanged type and all of the turning and drilling has to be accurately performed in order that the work may fit properly when it reaches the assembling department. Fig. 1 shows one of these new style exhaust pipes assembled on the engine, and by referring to

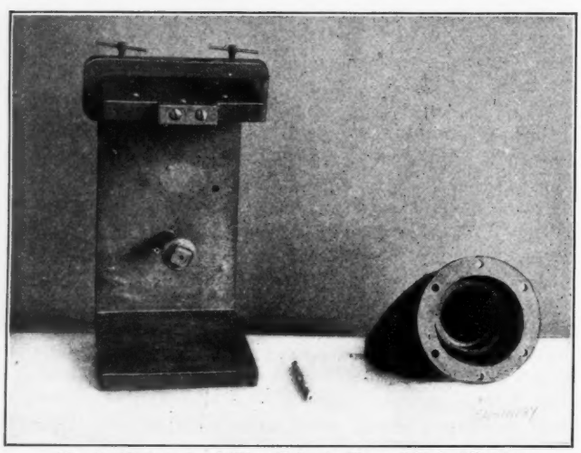

Fig. 2. Fixture for drilling Holes in Flanged End of Header

this illustration the arrangement of the different sections of the pipe will be clearly understood.

Fig. 2 shows the fixture which is used for drilling the holes in the flanged end of the header which bolts onto the engine cylinder. The casting is secured to the vertical plate of this

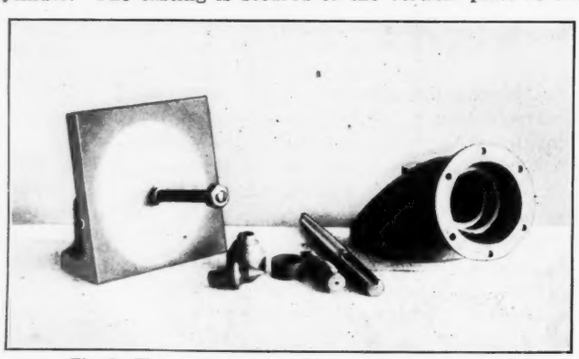

Fig. 3. Fixture for boring and turning Inside of Header

fixture by the bolt shown in the illustration, the work being located in the desired position by means of the three pins which fit the outer flange of the header. The holes are drilled through the bushings in the horizontal plate at the top of the fixture, which locates them in the required positions.

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Fig. 3 illustrates a fixture for turning and boring the inside of the header to receive the water-jacketed pipe on the exhaust tee. In order to operate properly, this joint must be a tight fit, and consequently the work must be done with considerable accuracy. The header is secured by the bolt on the angle-plate fixture, which is bolted on the faceplate of the lathe. This brings the work into the required position for turning the flange and boring the inside of the header, the final form of which is shown in the illustration.

The fixture shown in Fig. 4 is used for drilling the holes in the flanged ends of the vertical pipe and also the hole for the water piping in the side of the vertical pipe. The work is located in this jig by means of the bosses on the plates which carry the bushings. These bosses fit into the inside of the pipe and center it, ready for the holes to be drilled

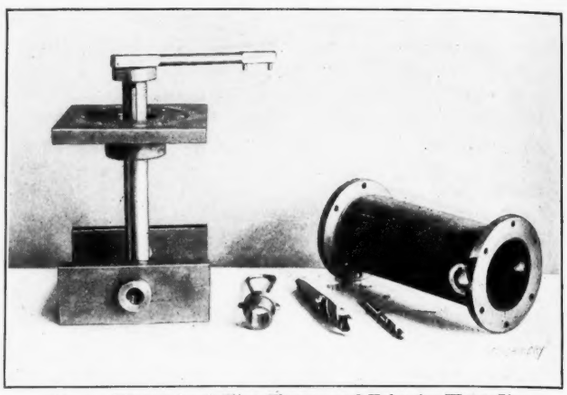


Fig. 4. Fixture for drilling Flanges and Holes for Water Pipe

through the bushings in the jig plates. The small drill shown in this illustration is then mounted in the drill press, and the six holes in the flanged ends of the pipe are drilled; the jig is then turned over on its side and the large holes for the water pipe are drilled.

The fixture shown in Fig. 5 is used for drilling holes in

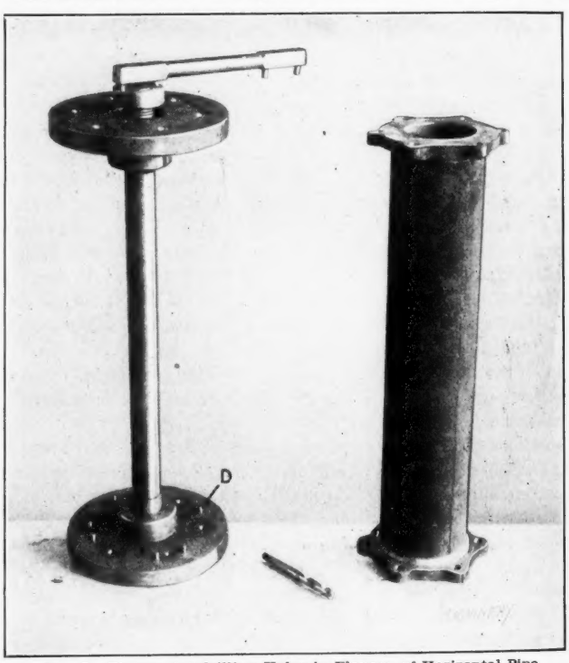


Fig. 5. Fixture for drilling Holes in Flanges of Horizontal Pipe

the flanged ends of the horizontal pipe connecting the two upright parts of the exhaust which are bolted to the engine. The pipe is centered in this jig by means of the pins *D*, which fit in either side of the extensions on the flange. When centered in this way, the holes can be drilled through the jig guides in the usual manner. When the holes in one end are drilled, the jig is reversed and the other end of the pipe is drilled.

Fig. 6 shows a fixture for drilling and reaming the bolt hole in the exhaust header. The work is located in the angle iron

in the exhaust header. The work is located in the angle-iron fixture by means of the small pins which fit into the holes in the flange and thus locate the work in the desired position. The hole is then drilled through the guide in the swinging arm. The construction of the jig will be readily understood by reference to the illustration. All of the fixtures are so made that they require no bolting or strapping to the drill press when drilling the holes, thus appreciably shortening the time which was formerly taken in securing the pipes to the drill press under the old method.

The special advantages of this type of exhaust pipe are that it can easily be assembled and taken apart; also

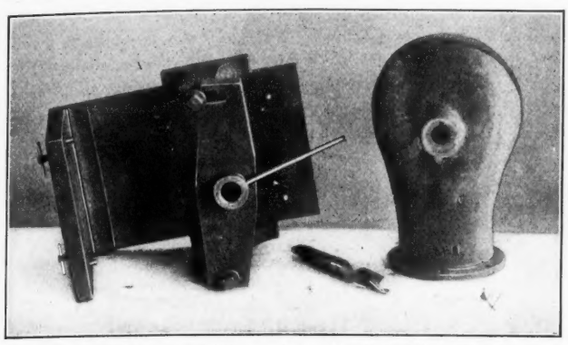


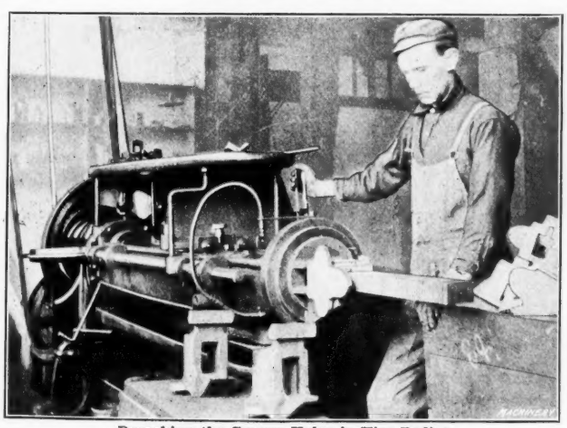
Fig. 6. Fixture for drilling and reaming Bolt Hole in Header

that the pipe is constructed in such a way that any one part can be taken out and renewed without requiring the entire pipe to be taken down, as in the case of the commonly used design of exhaust pipe for motor boat engines, which is of the screwed-together type. The present type of pipe is made entirely of cast iron, so it is not affected by the corrosive action of salt water as wrought iron pipe would be. As most of the machine work in this shop is done on the bonus plan, it can be readily seen that with these improved and adaptable fixtures, the cost of machining the work is greatly reduced.

* * *

BROACHING THE SQUARE HOLES IN VISE BODIES

We are accustomed to thinking of broaching operations as confined to the cutting of keyways and irregular-shaped holes of comparatively small dimensions. At the Reed Mfg. Co.'s shops at Erie, Pa., the broaching process is being used for finishing the square holes through which the sliding jaws of their



Broaching the Square Holes in Vise Bodies

vises operate. The old method of finishing these holes was to chip away the bulk of the stock, finishing by filing. Of course in casting, the holes are cored as closely as possible to size.

The illustration shows a broaching machine made by the Lapointe Machine Tool Co., Hudson, Mass., which is employed for broaching the holes in these vise bodies. Of necessity, the broaches used are heavy, and, of course, different sizes must be used for the various sizes of vises. The broach is cut with one side left blank or without teeth, except for the first quarter of its length. In operation, the broach cuts evenly on all four sides for one-quarter of the distance, just enough to clean out the cored hole. From this point on, the blank side of the broach slides over the work, allowing the other side of the broach to remove the excess metal. In this way the excess metal is always removed from the same side of the vise body, and it is possible to keep the work to a standard, thus insuring the alignment of the jaws in the finished vise. In order to keep the broached hole parallel with the base, the vise castings, while being broached, are held against a special supporting plate that is bolted to the head of the machine.

In addition to the better quality of work secured by this method, the rate of production is materially increased, it being possible to broach about twenty of these holes per hour, which is greatly in excess of the number which could be fitted by hand chipping and filing. C. L. L.

* * *

SELECTING THE CUTTER FOR MILLING SPIRAL GEARS*†

BY GEORGE W. BURLEY‡

As is well known by all mechanics, a number of different shapes of cutters are provided for cutting spur gears of any given pitch, the shape depending upon the number of teeth in the gear to be cut. Thus, for example, there are eight different shapes used for spur gears of the same pitch, according to the Brown & Sharpe system for involute gear teeth. This series of cutters takes care of any number of teeth from a pinion of 12 teeth to a rack. The fact that a certain cutter is suited to cut a 12-tooth spur gear, however, is no sign that it is suitable for cutting a 12-tooth helical gear, since the fact that the teeth are cut at an angle considerably alters their shape. The cutter to be used when milling spiral gears, therefore, does not correspond directly to the number of teeth in the gear to be cut, but the number of teeth is found by the formula

$$N_1 = \frac{N}{\cos^3 a}$$

in which

N_1 = number of teeth for which the cutter is to be selected,
N = actual number of teeth in the spiral gear,
a = the angle of helix or spiral.

It involves a rather lengthy numerical calculation to obtain the value of $\cos^3 a$, and therefore the table in the accompanying Data Sheet Supplement has been prepared to facilitate calculations of this kind. This table gives the value of $\frac{1}{\cos^3 a}$ which has been termed K in the table. When having access to this table, all that is necessary, in order to find the cutter for any given spiral gear, is to multiply the actual number of teeth in the spiral gear to be cut by the factor K as given in the table opposite the angle of spiral. The product thus obtained gives the number of teeth for the cutter to be selected.

As an example, assume that the angle of spiral is 30 degrees and that the actual number of teeth in the spiral gear is 18; then in order to find the number of teeth for which the cutter is to be selected, multiply 18 by the factor K found in the table opposite 30 degrees. This factor is 1.540; hence, $18 \times 1.540 = 28$, approximately. Therefore, a spur gear cutter for 28 teeth should be used. According to the universal system for these cutters, a No. 4 cutter is to be selected.

The simplicity of this calculation, as compared with the process when the third power of the cosine of the spiral angle must first be obtained and then the actual number of teeth divided by this value, is apparent. The table, therefore, will probably be highly appreciated by many of the readers of MACHINERY who frequently have to deal with spiral gear calculations.

* * *

The fire losses in the United States and Canada, during 1911, amounted to about $235,000,000. The cost of fires each year is equal to one-half the cost of all the new buildings erected in a year.

* See also, "To Find the Number of Cutter for Spiral Gears," MACHINERY, September, 1907.
† With Data Sheet Supplement.
‡ Address: University of Sheffield, St. Georges Square, Sheffield, England.

METHODS OF LUBRICATING MACHINE TOOLS*—1

A REVIEW OF OILING DEVICES AND SYSTEMS OF DISTRIBUTION

BY JOSEPH HORNER†

Among the many and varied aspects of machine-tool design and operation, that of the lubrication of the moving parts forms one of the most interesting features. Far more attention is now paid to this detail than was the case formerly. The higher speeds and duties which prevail, the use of geared drives, and the practice of boxing-in portions of mechanism have all had their effect upon the methods of lubrication, and many new and improved devices have developed and come into general use. The tendency is always to render the lubrication as far as possible automatic in the most complete systems, so as to obviate frequent attention on the part of the attendant and to minimize the consequences of neglect. The details of construction of machine tools are so complex and varied that it is not surprising to find a multitude of ways of supplying oil to the different elements, and we propose to deal with the principal of these, with the help of typical illustrations.

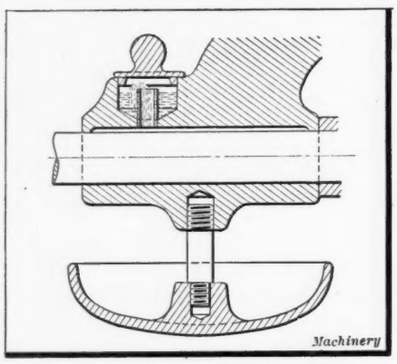


Fig. 1. Distribution of Oil supplied by Wick and Oil Groove

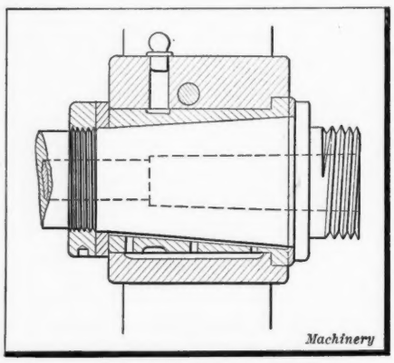


Fig. 2. Bearing with Reservoir and Drilled Bushing

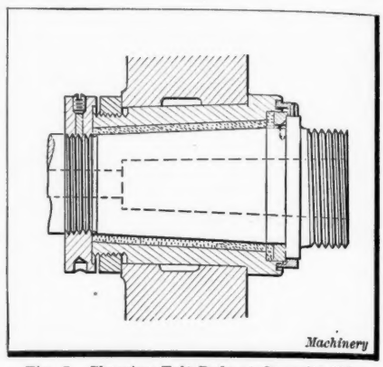


Fig. 3. Showing Felt Pads at Opposite Sides of Bearing

The question of lubrication divides itself naturally into two main heads, *viz.*, supply and distribution. Subsidiary to these are, the prevention of loss before the oil has done its work, the prevention of access of dirt to the surfaces, and the final catching after it has left the surfaces, with or without immediate return. In many instances it is necessary to prevent escape of oil onto belts and surfaces where its presence is undesirable.

Oil supply is effected by gravity, by pressure, by capillary attraction, by a mechanical lifting action which raises oil from a well, or by contact, through the medium of wicks, pads, or rollers. Distribution is effected by rows of holes, or grooves, by wicks or pads laid suitably, by rollers, or by the splash method.

Such diverse conditions are met with that it is impossible to claim any particular mode of lubrication as being the best for shafts or slides. The speed of rotation may make a vital difference in the results, or a method of oiling that is quite satisfactory in one machine may be undesirable or impracticable in another, on account of inaccessibility of the parts or great increase of pressures. With the use of the boxed-in geared drives in so many types of machine tools the difficulties of reaching the parts have increased, and some rather elaborate devices have been evolved for supplying and catching the oil without having recourse to the removal of covers. Pipes naturally play an important part in the conduction, and there is often extensive drilling of shafts and bearings for the purpose of conveyance from the outside.

Similarly, in the means provided for distributing and catching the oil, widely varied methods are adopted, ranging from simple pots or troughs under open-ended bearings to the highly-elaborated systems in which a forced supply is fed to the bearings, and is completely collected from these and returned to the sump for use over again. The latter system, if properly embodied in the design of a machine, is the best solution of the lubricating problem, since the supply is constant and ample, and the trouble of attending to numerous lubricators is obviated. More thorough flushing of the bearings is also insured, and any dirt is carried away quickly, instead of being churned up for a considerable period, to the detriment of the surfaces, while cooling is more effectual also. With the same idea in view it is often the practice to obtain the oil for the journal bearings of a gear-box from the well in which the gears splash around, in place of providing each bearing with a separate well.

One of the greatest differences which affect the lubricating problem is the quantity of oil which has to be supplied, and

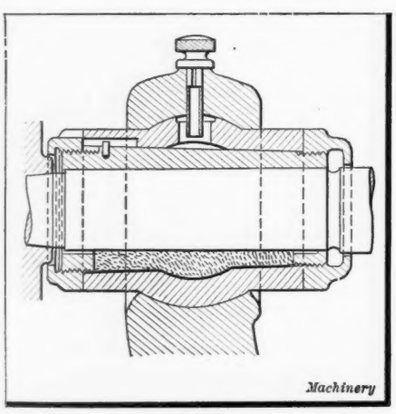


Fig. 4. Showing Felt Pad and Spring in B. & S. Grinder Head

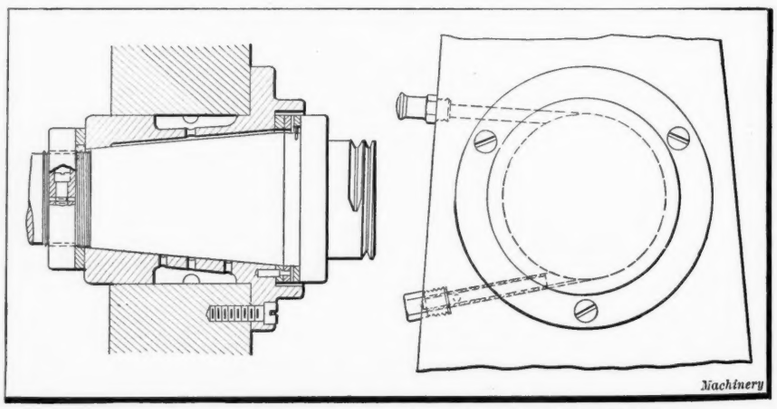


Fig. 5. Spindle Bearing with Reservoir and Distributing Holes (Garvin Machine Co.)

* For similar articles on machine tool details previously published see: "Machine Handles," June and July, 1912; "Forms of Lathe Beds," January and February, 1912; "Adjusting Strips or Gibs on Machine Tools," April, 1911; "Types of Milling Machine Braces," July, 1911; "Clamps and Locking Devices Applied to Machine Tools," December, 1910; "Machine Stops, Trips and Reversing Mechanisms," September, 1910.

† Address: 45 Sydney Bldgs., Bath, England.

this depends on the function of the moving part. It it runs at a good speed, under considerable duty, a copious supply is essential to prevent cutting and heating, but if the movement is slow or intermittent and the work light, a simpler system meets the case. In sliding ways which run at high speeds and carry much weight, ample lubrication is imperative, while on the other hand such parts as cross-slides, and tool-boxes, etc., which move slowly or intermittently will retain their film of oil for a long period without a fresh

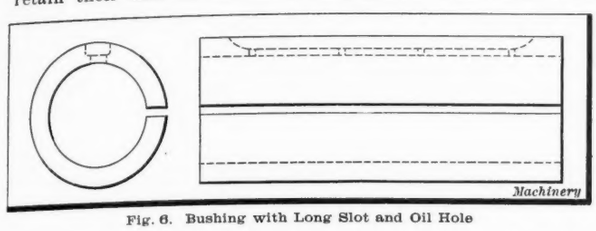


Fig. 6. Bushing with Long Slot and Oil Hole

supply. The horizontal or vertical dispositions of sliding surfaces also make some difference in the amount of oil which can be fed. Certain horizontal ways admit of flooding without inconvenience, while this cannot be done with a vertical slide, nor would it usually be necessary.

Even though ample lubricant is fed to a bearing or slide, this is of little avail unless distributed correctly and evenly, so that no parts of the surfaces become dry. It is not sufficient to drill a hole and trust that the oil will get between two surfaces beyond the vicinity of the hole, although this is often done in cheap work. The oil must be distributed to right and left in a definite manner, with due allowance for

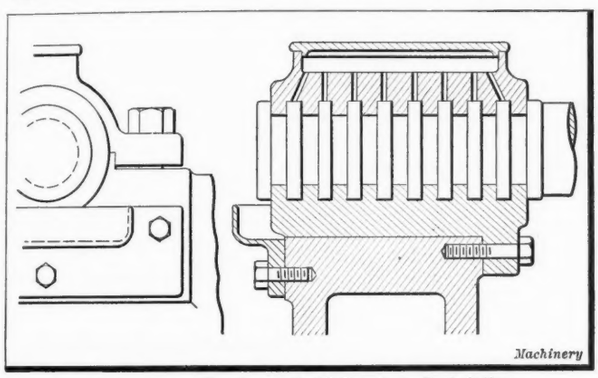


Fig. 7. Thrust Bearing with Oil Supply to Each Collar

possible clogging. The two chief methods of effecting the spreading are grooves or channels, and pads of felt. The first-named is satisfactory provided the quantity fed in is sufficient to carry it the required distance; the latter has the merit of absorbing a good deal of oil and keeping the surfaces moist for a period even after neglect, and it also prevents the access of grit if properly fitted, which grooves alone do not. Sometimes a compromise is made, using grooves and pads together. If the pads are let into a well of oil, a certainty of supply is guaranteed, though this will not distribute such an amount of oil as some other methods.

The arrangements for catching and draining oil from a surface or bearing influence the mode of feeding to a certain extent, and the two must be intimately related. A copious quantity of oil does not do much good if it is permitted to run out quickly and has to be collected in a primitive fashion, with inevitable waste and soiling of the machine. Under the pump and flooded bearing system this is practicable, but for ordinary use a moderate amount supplied at intervals is better. When, however, each bearing is self-contained, with a ring-oiling or similar system, the amount of oil passing constantly is not restricted, but depends on the method of lifting adopted. There is no waste here, because the oil from the surfaces returns to the reservoir and is carried again to the points at which it is needed.

The methods of feeding lubricant vary with circumstances and include: 1. The simple oil-hole, fed from a can, with no means of retaining a supply. 2. The Stauffer class of cup with forced feed, obtained by screwing down a cap or

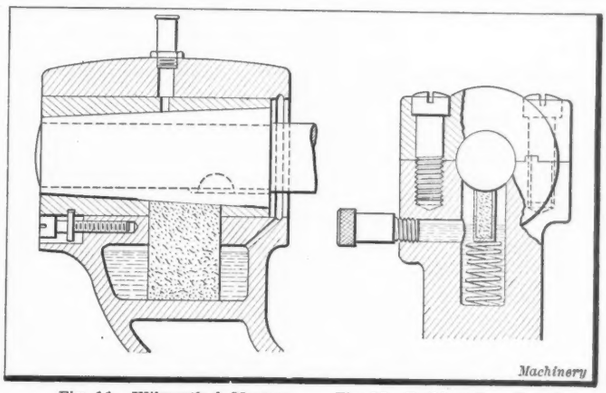


Fig. 11. Wilmarth & Morman Pad and Reservoir System

Fig. 12. Builders Iron Foundry Pad and Reservoir System

plunger. 3. The siphon cup with a wick feeding continually by capillary attraction. 4. The grease-cup device with constant feed by spring pressure. 5. The distributing box system with pipes and control taps to admit certain quantities of oil to the leading-out pipes. 6. The needle lubricator in which the feed is produced by the vibration caused by the rotation of the shaft. 7. The oil-well or reservoir which is filled to a definite depth, and serves to lubricate by wicks, etc., or by the splash method for a long period. 8. The force-pump which delivers a large amount of oil to one or several locations.

It is necessary to provide some way of observing the supply of oil. Many of the wells and lubricators may be inspected by opening a cover or door, or moving back a slide. Where, however, there is no means of readily accomplishing this inspection, sight or gage-glass tubes are fitted in which the height is visible, or a glass window is attached to the wall of a box or well. Glass-bodied lubricators often take the place of those with solid metal bodies in places where they are permissible. Occasionally a float gage is utilized to indicate the level of the oil. With a gear-box of ample capacity, no indicator may be necessary, since a certain amount is

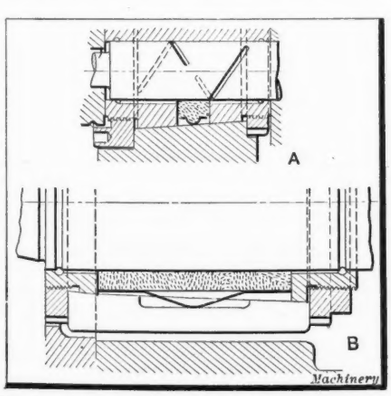


Fig. 8. (A) Narrow Pad in Bath Grinder Spindle. (B) Long Pad on Plain Spindle Landis Grinder

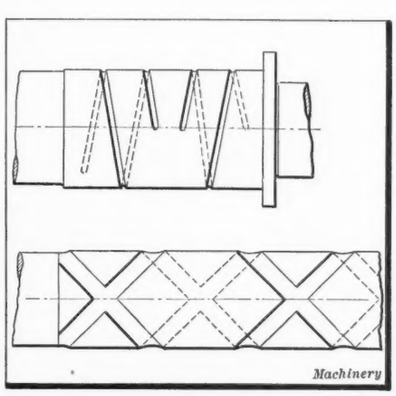


Fig. 9. Single and Double Grooves for Oil Distribution

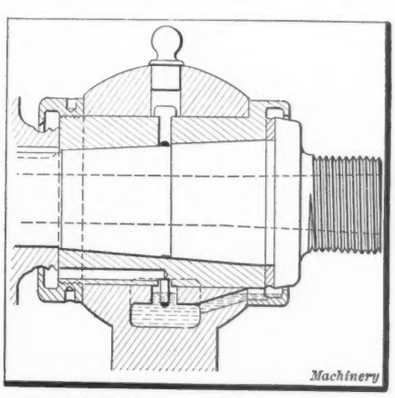


Fig. 10. Section through Hendey Ring-oiled Spindle

poured in, sufficient to last for so many weeks or months; and in the case of some ball-bearings a grease supply sufficient for a year or so is put in and the casing closed up.

The access of dirt and grit is guarded against by using strainers and filters. In a well system of lubrication the sediment naturally falls to the bottom, and care should be taken that it is not stirred up again; in fact many bearings embody provision for keeping the sediment quite out of the way where it cannot possibly be returned. Drain-plugs at the

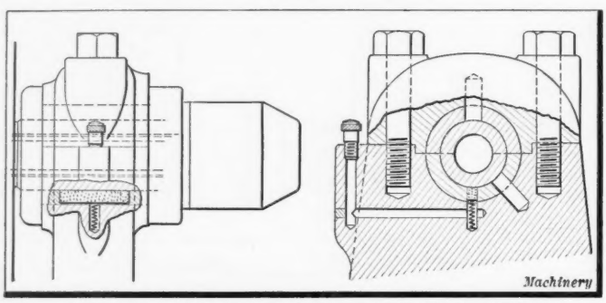


Fig. 13. Pad and Reservoir System with Supply from Side

lowest position provide for the drawing-off at intervals. When using felt pads, there is opportunity to make these assist in keeping the surfaces clean by a wiper-like action which prevents access of foreign particles between rotating or sliding faces. The amount of protection which must be afforded to bearings and parts depends on the nature of the processes carried on, or what is done in the shop besides. Anything in the way of grinding demands rigorous guarding of all open-

Fig. 14. Reed Wick Oiling System employed in Place of Pads

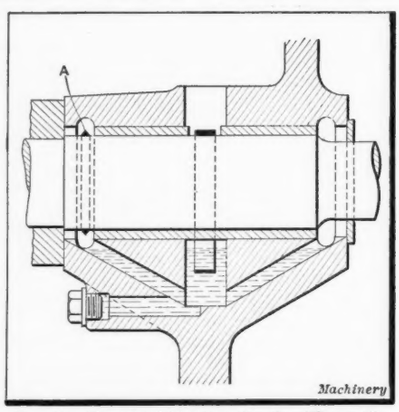


Fig. 15. Ring-oiled Bearing showing Throw-off Collar

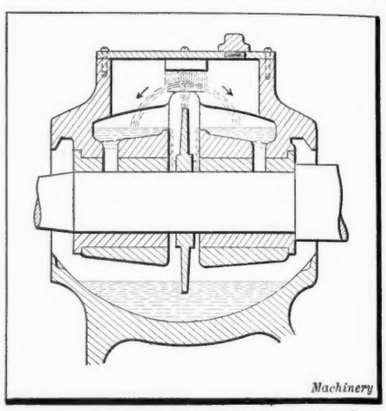


Fig. 16. Bearing lubricated by Disk and Distributing Box

ings where access is possible, and felt pads and disks are used largely for such purposes.

As mentioned, the most primitive mode of oiling is that of drilling a hole and pouring oil in, leaving it to work its way along the bearing. An advance on this is to groove the bearing, as seen in Fig. 1, so that distribution takes place properly, and to fit a constant feed—in this case, a siphon pipe and wicking. The waste that drips from the bearing ends is collected in the drip-cup. Such a bearing is very suitable for light and moderate duties, and will run for a long period without attention, although it is not so suitable for high-speed shafts which require flushing and continual movement of the oil to let them run cool and smoothly. On many bushings and bearings the oil is distributed, not by a single hole and groove in the journal, but instead a long slot is cast, Fig. 6, and several holes are drilled through. This is convenient in some cases, especially where bearings are difficult of access. and where they have a longitudinal movement which would bring a single feeding opening out of the range of a pipe. Two holes are also often drilled through near to either end of a long bearing, so as to insure a distribution from both ends.

Fig. 2 illustrates a spindle-box construction (for a Hendey Lincoln miller) in which the outside of the bushing has a groove turned in it for the purpose of allowing the oil which is fed in through the plugged hole to pass round and down into the chamber in the box. Sufficient oil is introduced to rise up through the holes and spread by way of the groove all along the spindle body.

In the Garvin millers a drilled box is fitted (see Fig. 5) and is recessed to form a reservoir, the oil passing through the holes and along the grooves. The thrust washers are grooved also to distribute the lubricant. The oil-cup at the top and the drain-plug at the bottom are seen in the end view.

Thrust journals constructed with a number of collars may be lubricated on the separate passage system, Fig. 7, a hole for each collar leading from the common reservoir. This example is taken from a heavy planing machine table-driving screw; the illustration also shows the application of a trough below the end of the bearing to catch waste, a fitting that is very commonly used in various types of screws and other bearings that come at the ends of framings. Alternative practice is to cast a well below the collars of sufficient width to include them all, and fill this. The collars then are constantly smeared, avoiding the possibility of one or more running dry due to the hole being blocked with some foreign substance, as may happen with Fig. 7.

Examples of various methods of applying felt pads for distribution are seen in the following illustrations, either being used alone, or in combination with grooves in the bushing or on the shaft. The felt not only insures a supply of oil on every part of the journal that it touches, but it filters the oil as well, and prevents the passing of grit or particles of metal. The pads are fitted into slots cut in boxes or bushings, and either dip into a well, or are simply fed through holes by a cam, or from some type of lubricator. Fig. 3 shows a bearing with two felt strips laid in slots in the bushing, no oil distributing grooves being cut, because the strips are equal in length to the running surface. Fig. 4 from a Brown & Sharpe grinder wheel head, illustrates the fitting of a long felt strip, pressed up by a curved spring. The oil falls from the leading-in tube and passes around the annular chamber in the bearing. Fig. 8, *A* and *B*, from Bath and from Landis grinders, respectively, show the use of a narrow, and of a wide pad; in the first case the oil is carried to right and left by the grooves on the spindle; in the second there are no grooves. Both examples have collecting chambers in the bearings and

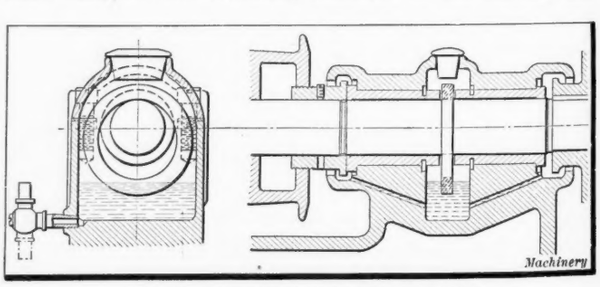


Fig. 17. Ring-oiled Bearing for Disk Grinder

channels to return to the pocket containing the pad. Fig. 9 represents two other arrangements of grooves on shafts. Many firms now favor this practice instead of cutting grooves in the bearings, the advantage being that the rotation of the shaft carries the oil along positively.

The pad is often let into a capacious well holding sufficient oil to last for a long period (Fig. 11) with provision for the return of the waste oil by a channel from the end or ends

of the bearing. Figs. 12 and 13 show two variations in practice, the first having a side fed well, and a pad contained in a brass holder pressed by a spring, and the second a modified arrangement, with the oiler set vertically. This disposition is sometimes more convenient for certain machines than placing it on top of the bearing cap, and there is the advantage that grit cannot reach the spindle, as it may when the supply is poured down from above. Alternatively to the fitting of a pad, wicking is sometimes adopted, Fig. 14, feeding to the top side of the shaft, the ends being joined to prevent displacement. One or two such wicks are provided, according to the length of bearing. The system most extensively employed for spindles and shafts is the ring-oiling method, which insures a larger flow than is caused by the pad device. It is used in conjunction with a reservoir for each bearing, or with a reservoir or box common to several bearings. If a gear-box, for example, has a body of oil into which the gears run, passages can be arranged to lead to the bearing wells, which

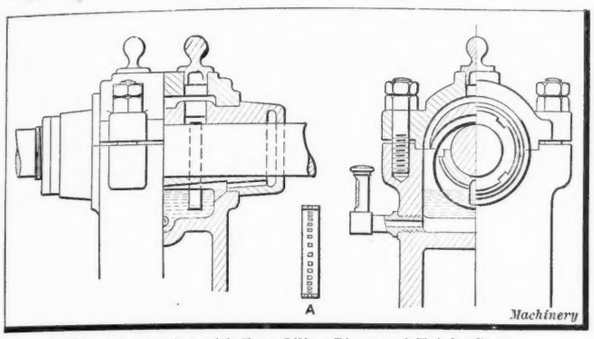


Fig. 18. Bearing with Two Oiling Rings and Height Gage. (A) Perforated Ring

simplifies arrangements. Or the bearings may be constructed in a self-contained manner if they lie out of the plane of the oil box. Fig. 10 shows a section through a typical ring-oiling bearing, with a well of moderate capacity, and channels for the return of oil into it. It will be noticed that the hub of the gear to the left has a vee-shaped projection turned on it to prevent the passage of oil, which is thrown off this high part into the recessed collar-nut; and when the spindle comes to rest, the oil on the surface drops off into the collar, as it does also at the front, from the highest portion of the shoulder. A drain hole extending laterally provides for cleansing.

The two sectional views, Fig. 17, give an example of a long

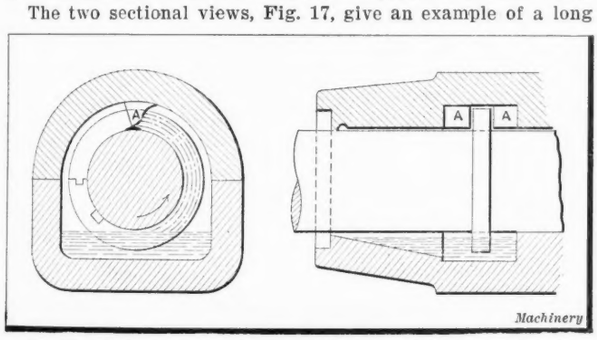


Fig. 19. Builders Iron Foundry Ring and Scraper Method of Lubrication

bearing (for a disk grinder) with a ring, and grooved brasses. A capacious well is cored out, with a draining pipe, which is turned downwards to empty. When in the vertical position indicated, the well is filled until the pipe is filled nearly to the top, and the inlet is then plugged. The square shoulders on the pulley collar and the disk throw the oil off into the annular recesses whence it drains down into the well.

A common device to prevent creeping of oil along the shaft to the outside of the bearings is a vee-shaped ring, *A*, Fig. 15, which throws the creeping oil off into the recess. At the other end the bearing is sealed by a washer, and any oil coming against the face of this runs down to the drain channel. Another mode of arresting the creep which often takes place while a shaft is at rest, is to turn a shallow groove near each end; the oil will not pass this, but will travel so far, and then collecting at this point will drip from there into the reservoir, or into a channel communicating.

In long journals it is often the practice to employ two oiling rings to provide greater quantity and better distribution of the lubricant. An instance of this is seen in Fig. 18, which also illustrates the gage-glass fitted to observe the height of oil. Sediment collects in the well at the bottom, out of the range of the rings. In a few cases the plain ring is not employed, because it will not lift enough oil for the requirements of the bearing, particularly if it should not happen to run freely in consequence of thickening of the oil. Some

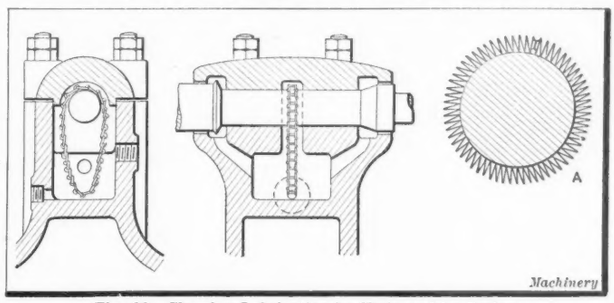


Fig. 20. Showing Lubrication by Chain and by Spring

kind of auxiliary lifting is pressed into service, such as little scoops on the periphery, or projections, or recesses, or the ring is punched with holes, Fig. 18, *A*.

In all the examples shown, the ring is hung loosely on the spindle, and revolves at a slow rate. If it is fixed to run at the same speed, the action is not sufficiently effective, because the centrifugal force throws the oil outwards and very little of it can reach the shaft. When some manner of catching or scraping the oil off the ring is included, this arrangement is not objectionable. For instance, in Fig. 16 (employed in the

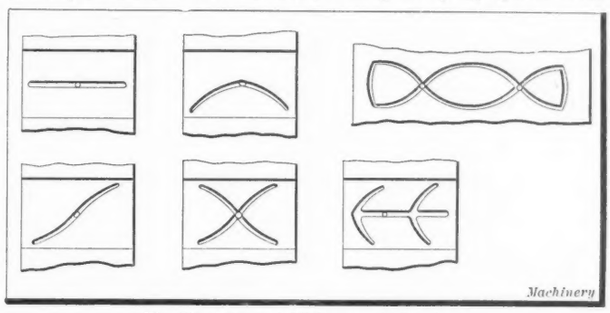


Fig. 21. Types of Oil-Grooves in Bearings

disk grinders of Roberts Bros. of Manchester, Eng.) the fixed ring or elevator disk throws the oil up into the distributor at the top, whence it flows onto and along sloping surfaces which communicate by vertical holes with the top of the bearing. Some high-speed spindles have a filtering arrangement incorporated; the oil is thrown by the disks into a trough at the top, and it runs along this into recesses filled with filtering material through which no foreign particles can pass into the bearings. Instead of providing a gage-glass for inspection, the simpler plan of screwing a brass window plate with a small piece of glass inserted is adopted.

Scraping action is represented by Fig. 19 (Builders Iron

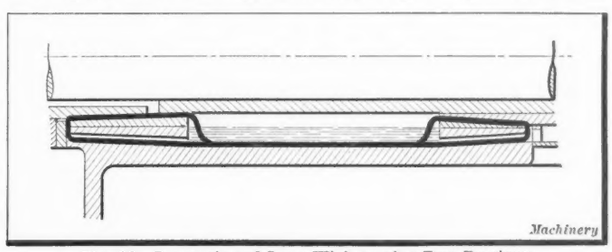


Fig. 22. Reservoir and Long Wick serving Two Bearings

Foundry), the ring being keyed to the shaft; at the top are two lugs or scrapers, *A*, with only sufficient space between them for the ring to revolve. The result is that the oil raised is scraped off the ring and thrown into the grooves in the bearing.

Chains, of ordinary, or pitch type, supply an effective way of lifting a good quantity of oil, and they are employed largely.

Such a bearing, on a grinding machine, is shown in Fig. 20. The view shown at *A* represents a compromise between the chain and the solid ring—a spiral spring looped and hooked together to revolve with the shaft. A means of oiling shafts, used to a limited extent, is a roller of wood or cork floating up against the shaft and smearing it.

We have shown arrangements of shaft grooves for the distribution of lubricant. Much variation exists also in the grooving of bearings, a few examples being shown in Fig. 21, ranging from single to more elaborate forms. The grooves may extend around half of the brasses only, or completely around.

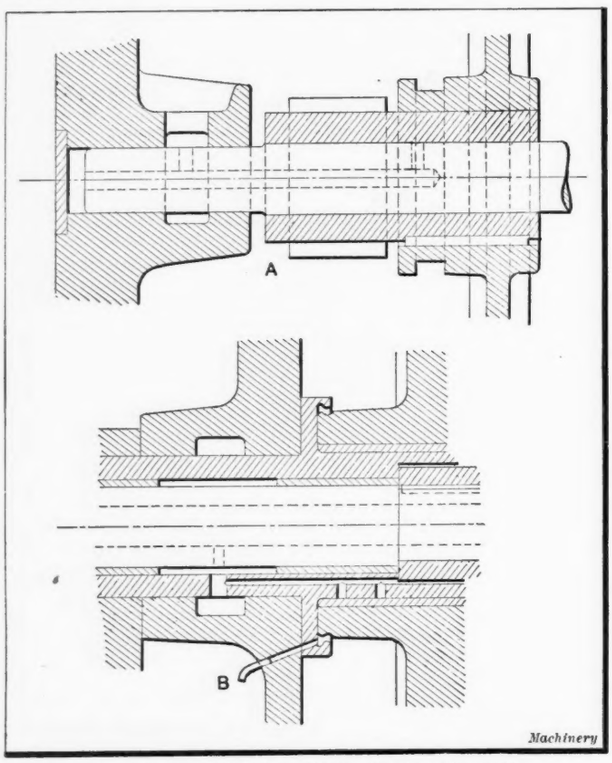


Fig. 23. Loose Running Wheels oiled from Reservoir

A method of lessening the tendency to heat, and of providing good lubrication is to employ graphite inserts, a brass netting being first prepared, and filled with a number of blocks of graphite, spaced rather closely, and the whole poured with babbitt, which is afterwards rolled and bored.

The example of wicking used to conduct oil to a bearing illustrated in Fig. 1 is an instance where various other means might have been adopted for feeding the oil. However, wicking is now largely utilized to supply bearings in a manner that could not be accomplished by pads, or at least not so well. The principle is to trail the piece of wick in the oil reservoir, and lead it from there to the bearing surface; this is a very elastic and accommodating principle, and possesses two main advantages. One is that the oil is filtered and consequently no dirt is transmitted by the wick; the other, that a feed can be procured from a well or gear-box not necessarily situated close to the bearing. If the wick is in proper condition, and the oil supply is maintained, there is no risk of the bearings running dry. No direct stream of oil ever reaches the bearings, since the wicking is arranged in such a fashion that the oil only climbs by capillary attraction. The bearings of the Hardinge bench-lathes, Fig. 25, afford an example of this; the wicks are laid in recesses at the bottom of the journals, and hang into vertical oil wells, these being filled from lateral holes at the rear of the head, with closed oilers. Fig. 22 represents the application of long wicking to feed two bearings.

A subsidiary advantage of wicking is that it can be employed to convey oil through a hole in the side of a reservoir or cup divided by a partition into two chambers. One of these is never opened to the air, and cannot receive flying grit or dust from the shop, but only forms a passage to lead the wick to the bearing surfaces. The other chamber contains the wicking coiled up in a mass to absorb oil, and the communication between the chambers is such that no direct flow can occur to wash undesirable substances along.

A good many ingenious devices exist for conveying oil to bearings and wheels which cannot be quickly reached in the ordinary manner, or which may be quite inaccessible when the machine is assembled. And cases also occur in which it is preferable to feed the parts from a central supply, or from a well adjacent, in place of fitting a separate lubricator. Such an example is shown in Fig. 23, taken from a milling machine, the view *A* showing conveyance from a fixed drilled shaft to the loose running wheel. The shaft receives its oil from the well cored out in the bearing, this being fed by the forced system which floods all the bearings. *B* represents the feeding of a wheel which runs on the bushing through holes communicating with the flooded reservoir. The edge of the wheel is lipped, and is enclosed by the turned-in rim of the bushing, so that superfluous oil is caught and drained down through the channel and pipe to the inside of the framing to the oil tank.

Pump systems embody many arrangements of a varied character for the thorough distribution of the lubricant. In the most complete gear-boxes, and in some machines—notably all-geared milling machines—the same supply is utilized to flood the gears and bearings, being pumped up from the well at the base and falling from a perforated pipe in cascades on to the gears, while suitably arranged pipes conduct it into the bearings. The top part of each bearing is cast as a trough, and the one below it catches the oil that runs out from the ends or center hole of the bearing. Grooves, holes, chutes, and pipes are employed to assist in the conduction. Fig. 24 is a sectional view through the frame of the Kearney & Trecker all-geared milling machine to show the various bearings and passages for the conveyance of the oil. The oil flows from the ends of the pipe at the top, and for the spur gears it drops

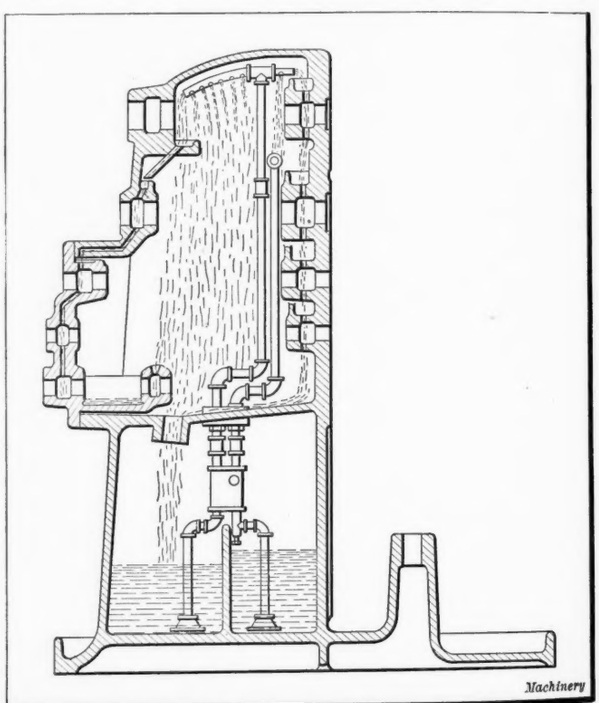


Fig. 24. Milling Machine Framing for Flooded Bearing System of Lubrication

from the holes on the under side so as to cover the entire area. Finally it runs on to the dividing web of the frame and passes through a hole into the reservoir, from which the pump raises it again to the top. The reservoir to the right is completely separated, and has its own pump and piping to convey the lubricant for the cutters. Many modifications of this arrangement might be illustrated, but this must suffice to show the general principle. When bearings of fixed or tumbler type happen to be situated between the sides of the framing, these can be supplied from the distributing pipe, either by a simple fall onto a lipped surface which collects the oil and lets it

run into the bearing apertures, or the employment of supplementary piping which reaches around obstructions that prevent a direct fall. If it is impossible to properly feed such bearings, or running wheels, or if they happen to come outside the framing, an internal feed must be arranged, as already shown by Fig. 24. In this way it is practicable to lubricate all the running shafts and spindles without recourse to inde-

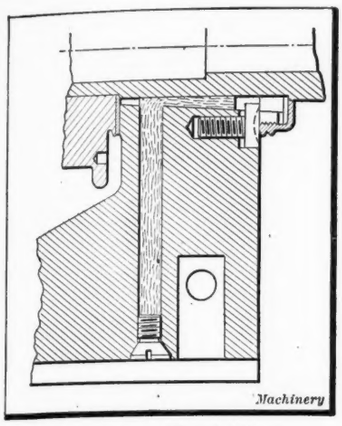


Fig. 25. Hardinge Wick Lubrication

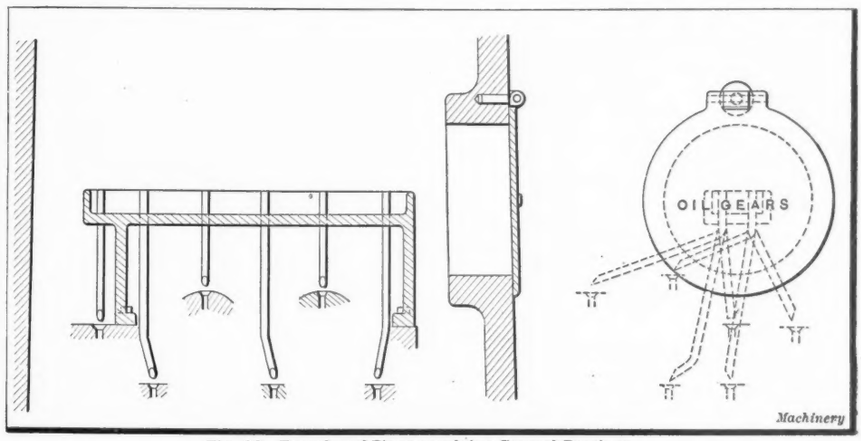


Fig. 26. Trough and Pipes supplying Several Bearings

pendent lubricators. One little difference exists in regard to the oil-grooves in a flooded system, and that is they may always be cut in open style, to let the oil run through freely and carry anything foreign with it. On the contrary in a restricted supply from oilers, the grooves are frequently cut with closed ends, to retain the lubricant for a reasonable period. It is essential to close the ends of the bearings with caps, either bolted onto the face, or driven into the bore, and made tight with a coating of shellac, or with packing washers.

In very large machines, when a considerable quantity of oil has to be flooded through bearings and over surfaces, a head is obtained sometimes by the use of an elevated tank, from which pipes lead down to the various grooves or passages. The pump then replenishes the tank at the required rate, the oil being filtered before returning. Any blocking of the long pipes should be provided against by the inclusion of pet-cocks at suitable positions, close to the bearings, so that the position of an obstruction can be discovered.

Apart from this method of obtaining a large supply, the tank is also often embodied in portions of machines to feed certain details that are either inaccessible by an oil-can, or are too numerous for individual attention, and there is thus risk of neglect. The oil either runs direct to the places needed, or is fed slowly by siphon wicks. So long as the tank is filled, kept clean from grit or dirt, and the wicks are fitted properly, no trouble can ensue. Fig. 26 illustrates a typical case, where all the oiling orifices are located close together, and the pipes from the trough do not need to be carried far. As the trough is enclosed inside a column closed by the flap door no lid is needed to cover the oil, but such would be required if the trough were situated externally.

* * *

Happily for the common welfare, not all manufacturing concerns believe in the policy of "oslerizing" old employes. Some whose product is noted throughout the manufacturing world for excellence and durability pursue quite the contrary policy, and do it in a way that wins general appreciation. For example, the Skinner Chuck Co., of New Britain, Conn., presented a Christmas gift of a $20 gold piece to each of its employes who had been in the company's service more than twenty years. The three men, Joel Bloomquist, James Kindelan and Joseph Preissl, who were the recipients, found in their pay envelopes, an extra envelope containing the $20 gold piece and a note stating that it was a Christmas gift from the company in recognition of their long and faithful services. It is hardly needful to say that an action of this kind by a manufacturing company does more to endear it to its employes than many of the so-called welfare works which are heralded as great philanthropies for the benefit of workmen.

PITCH DIAMETERS FOR METRIC SYSTEM SCREW THREADS

In MACHINERY's Data Sheet Book No. 1, "Screw Threads," pages 32 to 35, tables are given of the pitch diameters of U. S. standard threads, for all diameters varying by thirty-seconds, and for number of threads per inch varying from 6 to 64. No table, however, has been published giving the pitch diameters of metric screw threads, including all standard and special millimeter sizes. The accompanying table has, therefore, been calculated. It gives the diameter in millimeters and the equivalent diameter in inches, the pitch in millimeters, and the pitch diameter in inches.

PITCH DIAMETERS FOR METRIC SYSTEM SCREW THREADS

Diameter, Millimeters	Diameter, Inches	Pitch, Millimeters	Pitch Diameter, Inches	Diameter, Millimeters	Diameter, Inches	Pitch, Millimeters	Pitch Diameter, Inches
3	0.1181	0.50	0.1053	41	1.6142	4.00	1.5119
4	0.1575	0.75	0.1383	42	1.6535	4.50	1.5385
5	0.1969	0.75	0.1777	43	1.6929	4.50	1.5778
6	0.2362	1.00	0.2107	44	1.7323	4.50	1.6172
7	0.2756	1.00	0.2500	45	1.7717	4.50	1.6566
8	0.3150	1.25	0.2830	46	1.8110	4.50	1.6960
8	0.3150	1.00	0.2894	47	1.8504	4.50	1.7353
9	0.3543	1.25	0.3224	48	1.8898	5.00	1.7619
9	0.3543	1.00	0.3288	49	1.9291	5.00	1.8013
10	0.3937	1.50	0.3553	50	1.9685	5.00	1.8406
11	0.4331	1.50	0.3947	51	2.0079	5.00	1.8800
12	0.4724	1.75	0.4277	52	2.0472	5.00	1.9194
12	0.4724	1.50	0.4341	53	2.0866	5.00	1.9588
13	0.5118	1.75	0.4671	54	2.1260	5.00	1.9981
14	0.5512	2.00	0.5000	55	2.1654	5.00	2.0375
15	0.5906	2.00	0.5394	56	2.2047	5.50	2.0641
16	0.6299	2.00	0.5788	57	2.2441	5.50	2.1035
17	0.6693	2.00	0.6182	58	2.2835	5.50	2.1428
18	0.7087	2.50	0.6447	59	2.3228	5.50	2.1822
19	0.7480	2.50	0.6841	60	2.3622	5.50	2.2216
20	0.7874	2.50	0.7235	61	2.4016	5.50	2.2609
21	0.8268	2.50	0.7628	62	2.4409	5.50	2.3003
22	0.8661	2.50	0.8022	63	2.4803	5.50	2.3397
23	0.9055	2.50	0.8416	64	2.5197	6.00	2.3663
24	0.9449	3.00	0.8682	65	2.5591	6.00	2.4056
25	0.9843	3.00	0.9075	66	2.5984	6.00	2.4450
26	1.0236	3.00	0.9469	67	2.6378	6.00	2.4844
27	1.0630	3.00	0.9863	68	2.6772	6.00	2.5237
28	1.1024	3.00	1.0257	69	2.7165	6.00	2.5631
29	1.1417	3.00	1.0650	70	2.7559	6.00	2.6025
30	1.1811	3.50	1.0916	71	2.7953	6.00	2.6418
31	1.2205	3.50	1.1310	72	2.8346	6.50	2.6684
32	1.2598	3.50	1.1703	73	2.8740	6.50	2.7078
33	1.2992	3.50	1.2097	74	2.9134	6.50	2.7472
34	1.3386	3.50	1.2491	75	2.9528	6.50	2.7865
35	1.3780	3.50	1.2885	76	2.9921	6.50	2.8259
36	1.4173	4.00	1.3150	77	3.0315	6.50	2.8653
37	1.4567	4.00	1.3544	78	3.0709	6.50	2.9046
38	1.4961	4.00	1.3938	79	3.1102	6.50	2.9440
39	1.5354	4.00	1.4331	80	3.1496	7.00	2.9706
40	1.5748	4.00	1.4725	..	.....	....	.....

Machinery

* * *

Iron and steel ordinarily attain their maximum strength at temperatures of from 400 to 650 degrees F.

VARIABLE SPEED MECHANISM FOR MILLING MACHINE TABLE

A variable speed mechanism for rapidly feeding a milling machine table to the cutting point, then slowing it down for the cutting operation, and afterward quickly returning it to the loading position is in use at the Utica Drop Forge & Tool Co.'s plant, Utica, N. Y. This device is the patented idea of H. F. Kellemen, general manager of the concern, and one of the milling machines to which it has been successfully applied is shown in Fig. 1. The mechanism for producing the speed changes is located beneath the table, and in order to make its operation clear, it will be necessary to refer to Fig. 2, which shows a plan view of the milling machine table with a section broken out to illustrate the internal mechanism. The milling machine table, which is of the ordinary type, is represented by *C*, and the usual type of traversing screw is provided, being shown at *D*. The table is mounted upon the milling machine base and screw *D* runs through plain bearings *E*, *F*, and *G*, which are mounted upon the base of the

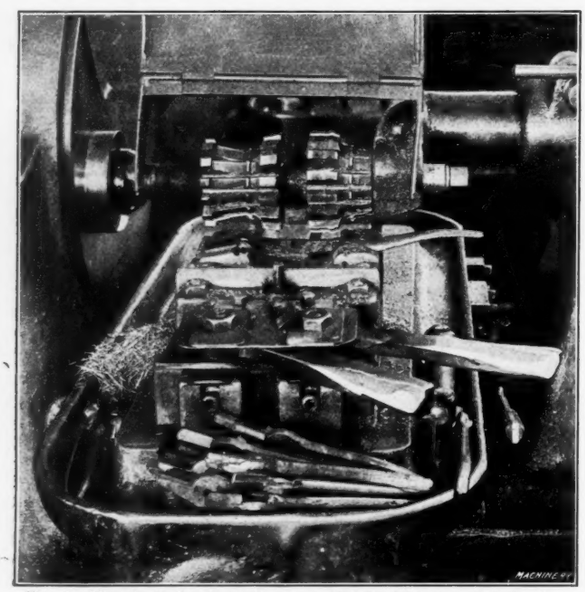


Fig. 1. Manufacturing Operation on which Variable Speed Mechanism is Advantageous

milling machine beneath the table. Confined longitudinally between bearings *E* and *F* is the pinion *H*, which is a sliding fit over the outside of the screw *D*, but is prevented from turning independently by means of a feather key in the pinion and a spline in the screw *D*. Between bearings *F* and

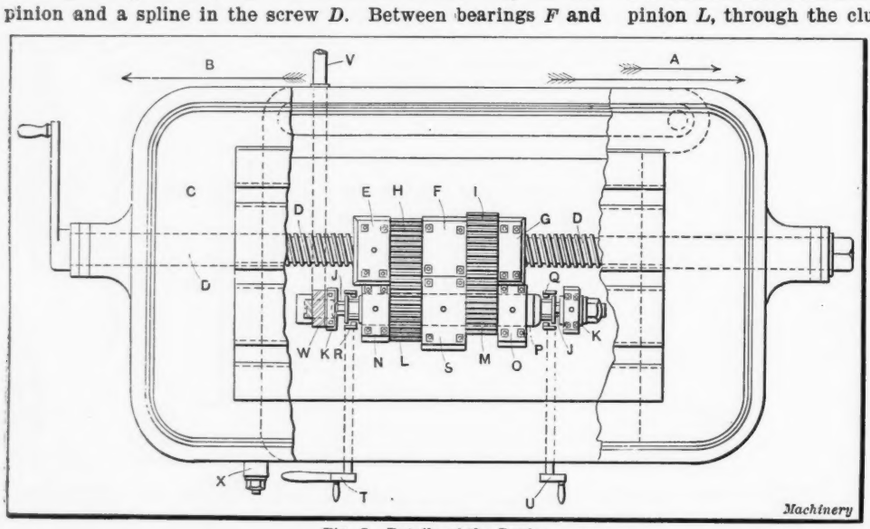


Fig. 2. Details of the Device

G is the rotatable nut *I*, internally threaded to fit screw *D*, the outside of which is in the form of a pinion. The sliding pinion *H* and the rotatable nut *I* should not be confused, as these are the essential factors in producing the speed changes. Mounted upon the base of the machine parallel with screw *D* is the jackshaft *J*. This jackshaft is supported in bearings *K* and upon it are loosely mounted pinions *L* and *M*. Driving shaft *V* continuously rotates the jackshaft in a constant direction through spiral gearing *W*. Within the housings *N* and *O* are clutch sleeves which encircle the jackshaft. The end of one of these clutch sleeves may be seen at *P*, and both these sleeves are keyed to, but capable of sliding along, the jackshaft. By means of teeth upon the ends of the clutch sleeves, which may be locked with teeth upon the sides of the pinions by the clutch mechanisms *Q* and *R*, either or both of these

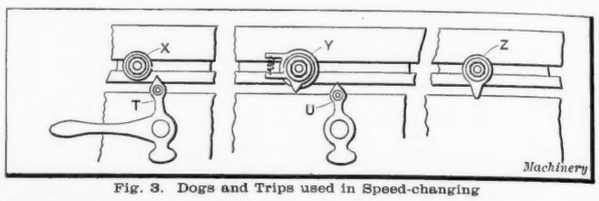


Fig. 3. Dogs and Trips used in Speed-changing

pinions may be coupled to the jackshaft, and thus operate the corresponding pinions on screw *D*. Within the housing *S* is a simple mechanism, which when either pinion *L* or *M* is keyed to the jackshaft, holds the other pinion against rotation. The clutches *Q* and *R* are thrown in or out of engagement by means of clutch rods which terminate in the dogs *T* and *U*. Thus, pinions *L* and *M* are thrown into or out of mesh with the corresponding pinions on screw *D*, when dogs *T* or *U* engage any of the three stops *X*, *Y* or *Z*, which are adjustably located upon the platen-side. These stops, as well as the dogs which operate the clutch shafts, are best shown in Fig. 3.

From the foregoing it will be seen that when the operator loads the work-holding vise on the table and throws in the lever dog *T* by hand, it causes clutch *R* to unite pinion *L* with the jackshaft and, consequently, to traverse the table in a rapid direction toward the cutters, as indicated by arrow *A*. This hand lever which the operator throws in may be seen at the right of the table in Fig. 1. The movement of the table is accomplished by the turning of pinion *H* driven by pinion *L*, which causes the screw *D* to turn through the pinion nut *I*, the latter being held from rotating at this time. Stop *Y* is located on the platen-side at such a point that when the table, and consequently the work, has reached the cutting point, the dog *U* is tripped, and this action, by means of the clutch rod and clutch *Q* throws pinion *M* also into rotation with the jackshaft. Pinion *M* then operates nut *I* in the same direction as pinion *H*, thereby greatly reducing the forward travel of screw *D*. This, of course, slows down the speed of the table as it feeds by the cutters, because the ratio between pinions *M* and *I* is much greater than between pinions *L* and *H*. Stop *X* is so located upon the platen-side that as soon as the cutters have finished their work it trips dog *T*, throwing pinion *L*, through the clutch mechanism, out of rotation with the jackshaft. As the pinion *M* on the jackshaft is still driving nut *I* on the screw, the direction of the travel of carriage *C* is consequently reversed as soon as pinion *L* is released from the jackshaft, and the carriage continues in the direction indicated by arrow *B* toward the loading point, until stop *Z* on the platen-side trips dog *U*, thereby throwing pinion *M* also out of rotation with the jackshaft. This brings the table to a stop, allowing the work to be removed from the vise so that it may be loaded for a second milling operation.

Summing up, it will be seen that there are three speeds given screw *D*; the fast forward speed when driven by pinion *L* in mesh with sliding pinion *H*; the medium return speed when the small pinion *M* drives through the threaded nut *I*; and the slow forward speed imparted when both pinions are driving screw *D*. The latter speed is the resultant obtained by subtracting the reverse speed from the forward speed.

C. L. L.

STEAM POWER PLANT PIPING DETAILS—1

DRAWINGS—GENERAL REQUIREMENTS OF PIPING SYSTEMS—ARRANGEMENT OF POWER PLANT PIPING

BY WILLIAM F. FISCHER*†

In steam power plant work, probably no detail of the layout requires more careful consideration than the steam piping, especially in medium and large size stations, where high pressures, superheated steam and high steam velocities are employed. A great many of the evils resulting from poorly or improperly designed piping systems are quite frequently attributed to other parts of the equipment. The successful and economical operation of the station as a whole depends to a large extent upon the general arrangement of the piping system; therefore, every engineer or designer connected in any way with the design, operation, or superintendence of steam power plant work should be familiar with the general requirements, at least, of a well designed piping system.

Drawings

Before any of the steam apparatus is finally located or installed in the station, the necessary steam and water piping systems should be worked out in detail. After the final blueprints of the engines, pumps, boilers, feed-water heaters, and other steam-driven machinery have been obtained from the manufacturer, the general arrangement of the plant should be decided upon and the apparatus located to scale on the general-arrangement drawing, after which the piping connecting the different units should be carefully worked out, taking care that proper clearance is allowed between the different apparatus and lines of piping, so that no serious difficulty may be experienced during the erection of the piping system as a whole or during its operation when installed.

All separators, valves, fittings, drip-legs, etc., should be drawn to scale in their respective positions, otherwise too much material may be crowded into a given space, making changes necessary during erection. Valves should be located in accessible positions and not crowded into a network of piping where it is impossible to reach them in a hurry. When indicating valves on a drawing, it is customary to show the flanges in their correct positions and to connect them by two crossed lines. If this is done care should be taken to see that proper clearance is allowed between mains to accommodate the valve, as the body of the valve, the handwheel and the rising stem, will project some distance beyond the flange limits. In crowded places it is much better to draw in the valve in full, or at least to show the correct position of the handwheel and stem, both in the open and closed positions, as this will tend to prevent errors and facilitate erection.

Valves should be arranged to be operated from the floor line or from operating platforms, where possible to do so. One frequently sees valves so placed in the line that the operator has to climb a ladder in order to operate them. When ladders are necessary for the operation of valves, they should, if possible, be built in, and a small platform or grating provided on which the operator may stand while operating or packing the valves. When important valves are placed overhead or in other inaccessible positions, they should preferably be equipped with a chain wheel and chain, or a system of gearing and extension stems, with the chain or handwheel in such a position that the valve may be operated from the floor line. Electrically operated "remote control" valves are frequently used in modern power stations for valves placed in inaccessible positions and which must be operated in a hurry. These valves are arranged with a system of gearing and an electric motor which is attached directly to the valve, and are operated by manipulating a controller located at any convenient point.

Some engineers merely work out their piping systems diagrammatically, allowing the piping contractor to work out all of the details, general location and arrangement of valves, etc. The contractor practically designs the systems to suit his own requirements and ideas, using the piping diagrams as a guide only. The excuse for this practice is that the piping contractor is better able to design the system to suit his own standards, and that he can then estimate closer on the work and save money for the client. The writer has been in the employ of piping contractors and has found just the opposite to be the case. When the contractor is given a diagrammatic layout on which to base his estimate, there is a large factor of uncertainty and ignorance regarding field conditions to be met, obstructions to be taken care of, etc., and for this reason, and also because he will be compelled to make his own shop and detail working drawings, and take care of all interferences in the field, he is bound to place a figure on the job high enough to cover engineering and drafting costs, incidentals, extras, etc. The practice of basing estimates and contracts on piping diagrams usually leads to misunderstandings between the designing engineer and the contractor, and quite frequently makes expensive changes and extra materials necessary during erection, all of which increases the cost of the equipment. It is, therefore, advisable that the piping system be well worked out on paper and carefully detailed before the piping contract is let. The drawing should show the location of all pipes, fittings, valves, steam separators, pipe hangers, etc., and should be dimensioned with center to center dimensions of all connections, so that the piping contractor can cut the pipe to the required length in the shop and ship it to the field ready for erection.

The drawings should be accompanied by complete specifications stating just what the contractor is expected to do, the type of valves, fittings, joints, gaskets, etc., and the quality of material required. The contractor should be allowed to use his own center to center and face to face dimensions of fittings and valves wherever possible, in order to avoid specials. In this way lower bids will be obtained on the work and the contractor will know just what conditions he is expected to meet. As a result there will be less chance of error and delay, due to misunderstanding between the engineer and the contractor. Piping diagrams should only be used for planning the piping system, and for operating purposes, in which case they will be found useful and convenient, as they show the complete system at a glance.

Shop and Field Cut Pipe

Pipe up to and including 5 inches in size can be cut, threaded and flanged in the field by hand, although this is much more expensive than to do the work in the pipe shop and send the pipe material to the field ready to bolt or screw together. One man and his helper, working in a pipe shop with power driven tools can cut, thread and flange more pipe in a day than a whole gang of pipe fitters could in the field when working with hand-power tools. In some cases it is advisable to leave certain dimensions to be obtained by the erecting crews, in which case the piping material up to a certain point will be cut and flanged in the shop, and the closing piece, or "filler," as it is known, will be cut to length and fitted in the field during erection. On a large job of pipe work the contractor sometimes finds it advisable to ship a portable, power-driven pipe machine to the field, in which pipe up to 8 or 10 inches in size may be cut and threaded. If the pipe work is to be furnished with "Van Stone," welded, or a similar type of attached flange, however, all of the pipe must be cut to proper lengths and flanged in the shop, as it is impossible to do such work in the field without the proper tools. With "Van Stone" and welded flanges, the joints must be faced off true and smooth after the flanges are attached, and this requires a long, power-driven lathe or pipe machine.

General Requirements of a Well Designed Piping System

To properly design a system of piping for a modern steam-power station, the designer should have some knowledge of operating conditions, and should be familiar with the manufacturers' standards, such as valves, fittings, separators, etc., and with the quality and strength of the materials employed in

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their construction. He should also have a general working knowledge of the methods employed in distributing and conveying steam and water, and for taking care of condensation, expansion, contraction, and vibration in steam mains.

When the boiler valve is closed, the steam inside the boiler, owing to its pressure, may be said to possess "potential energy," as it is capable of performing certain work when liberated. When the valve is opened, permitting the steam to flow through the piping system, part of this "potential energy" is transformed into "kinetic energy." Among the several factors which tend to change the form of the original energy of the steam, are condensation, friction, and expansion.

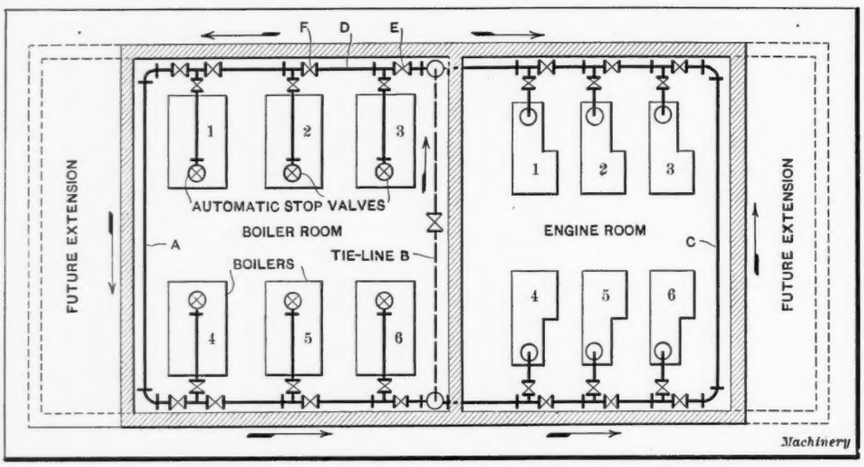


Fig. 1. Ring-main System of Steam Piping—Boiler and Engine Rooms End to End

Condensation in Steam Mains

When steam is turned into the piping system, part of it comes in contact with the inner surface of the pipe and fittings, thus transferring part of the heat to the metal of the pipe, from which it is transferred to the atmosphere surrounding the pipe. As the air near the outside surface of the pipe becomes heated to a higher temperature than that of the surrounding air, it quickly expands and rises, thus making room for cooler air which is in turn heated and rises, carrying the heat away with it. In this way a continuous stream of cool air passes over the surface of the steam pipes, robbing the steam of its heat and causing part of it to condense, or change back again into the form of water. The condensation which occurs when steam fills the pipe, but is not flowing through it, is known as "static condensation," and that which occurs while the steam is flowing, is known as "dynamic condensation." The amount of condensation has been found to be practically the same in both cases; therefore, no distinction is made between them when speaking of condensation losses.

In order to prevent excessive heat radiation and the resulting condensation losses, the steam piping system should be well covered or lagged with a good grade of non-conducting covering material. No matter how carefully the steam piping is covered, however, some water is still likely to accumulate in the system, due to condensation; therefore, the piping should contain no low spots or pockets in which water can collect. If water pockets are unavoidable, they should be dripped free of water at all times, and the water of condensation should be automatically returned to the feed-water heaters, or to the boilers direct, either through a system of steam traps, or a drip pump and receiver automatically controlled by a float-operated valve. Water pockets that are not properly drained are a constant source of danger, as the water of condensation will accumulate in them until picked up by a heavy flow of steam. It may then be projected with great force against a fitting, valve, blind flange, or sharp turn in the piping, in which case rupture is quite apt to occur; or the water might be swept into the engine cylinder by the flowing steam and thus cause serious damage to the engine. It is always advisable to install a steam separator in the steam line at a point near the engine throttle. Besides intercepting the "slugs of water" that may be carried over by the steam, and the moisture in the steam, the separator performs another function of great value in that it provides a reservoir of steam close to the engine, which cushions the reaction and absorbs the shock and jar caused by the quick cut-off in the steam chest.

Horizontal steam pipes should always be pitched in the direction of the flow, so that any water of condensation forming in the pipe or carried over from the boilers, will flow with and not against the current of the steam. When the water of condensation is made to flow against the current of the steam, "water hammer" is very apt to occur. For this reason it is not advisable to carry a steam line on an upward slope from a lower to a higher level. The pipe should rise vertically to the desired height and then be carried horizontally to the desired position, taking care that the horizontal pipes are pitched in the direction of steam flow. Drip-legs, or pockets, should always be provided at the base of a vertical riser, and should be automatically drained of water; otherwise the water would collect at this point, gradually decreasing the area of the pipe, until the first heavy draft of steam would carry a large "slug" of water with it through the riser and horizontal branch pipe above.

Friction

Friction of steam in the piping system is caused by the flowing steam rubbing against the inner surface of the pipe, valves and fittings, and by sudden changes of direction of the steam flow. Friction causes a loss of pressure in the piping, and this should always be taken into account when proportioning the pipe sizes for a given service. Loss of pressure in a steam pipe causes the steam to expand or increase in volume, and this, in turn, causes an increase in velocity at which the steam is traveling; that is, the velocity of the steam will vary slightly throughout the length of the pipe. Pipes and fittings should be carefully proportioned to permit of a free flow of steam from the boilers to the engines, without causing undue friction and loss of pressure in the system.

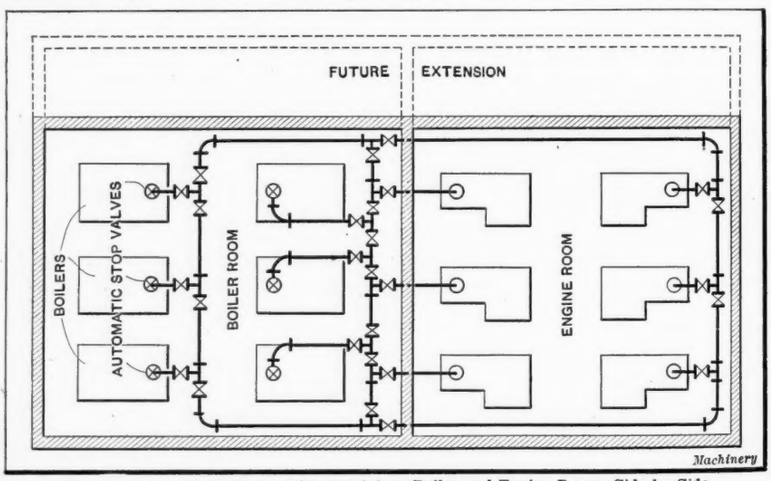


Fig. 2. Ring-main System of Steam Piping—Boiler and Engine Rooms Side by Side

Expansion and Contraction

Unless firmly anchored, the main steam header is subject to a change in position due to expansion and contraction strains in the main header and in the branches leading to and from it. In steam mains of any length, proper provision should, therefore, be made to take up or relieve the expansion and contraction strains as much as possible, thus preventing undue strains at the joints. Otherwise, leakage is liable to take

place, and rupture may be caused at the weakest point in the main.

Where a pipe line is anchored or fixed at any two points, an expansion bend of long radius should be installed in the line somewhere between the anchors or fixed points, as no ordinary system of anchoring or fastening will resist the force of expansion and contraction, and even if it would, the strains would fall on the pipe joints and cause trouble. The old type of slip expansion joints are now seldom, if ever, used in good steam piping, as they have proved a constant source of trouble, require frequent repacking and adjustment, and are extremely dangerous when used in high pressure work. Steel pipe expansion bends, of long radius, are now used to take up or relieve the strains on the piping system, in preference to any of the old-time expansion joints. Steel bends curved to a radius of less than six diameters are undesirable as expansion bends, because they are too stiff to take up the expansion in the line, and the strains are thrown on the fittings and joints. Expansion bends should be curved to a radius of, at least, six times the diameter of the pipe, and wherever possible, the radius should be greater, say from eight to ten times the diameter, in order to give sufficient elasticity.

Vibration

Steam, when flowing at a high velocity in the supply pipe of a modern high-speed engine is alternately stopped and raised again to this high velocity several hundred times a minute, due to the rapid opening and closing of the steam valves. This intermittent motion of the steam has, in many cases, been found to cause vibration in the engine supply pipe, which, in turn, is transmitted to other branches of the system. Vibration is also caused by suddenly changing the direction of steam flow through tees and short turn elbows, and sometimes by the unequal velocity of steam flowing through different branches of the piping system. Vibration, combined with expansion and contraction strains, is a constant source of danger and annoyance and should be guarded against as much as possible in the original design of the piping system. The pipes should be so proportioned that the velocity will be as nearly uniform as possible in all branches of the system. The engines should be equipped with steam separators of large capacity to cushion the steam, at or near the engine throttle, and the piping should be firmly anchored at suitable points.

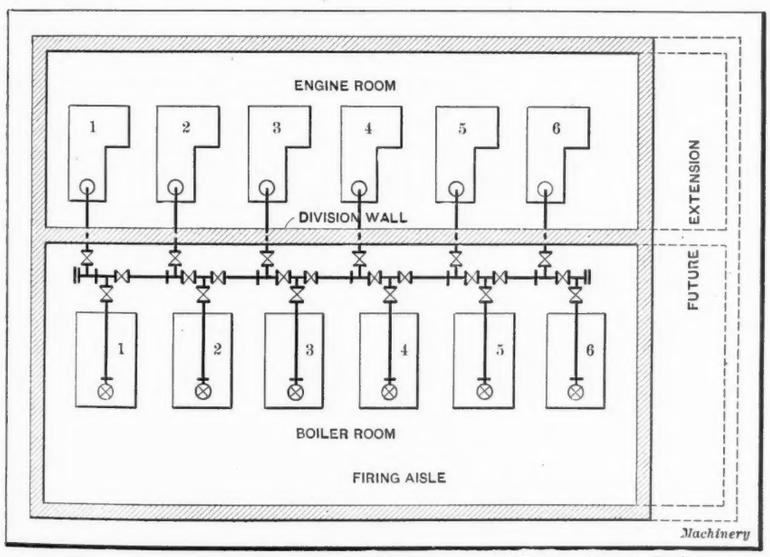


Fig. 3. Single-main System of Steam Piping—Boilers and Engines Back to Back

It frequently happens that vibration within the boilers or engines, due to some cause independent of the conditions of the piping system, is transmitted to the piping. In this case no amount of anchoring will cure the vibration. The cause must be found and remedied.

Steam boilers that do not contain sufficient steam space above the water line are subject to vibration, especially when steaming rapidly at overload periods. At such times the pressure is liable to fall off rapidly, causing a violent bubbling and boiling action within the boiler. This violent agitation of the water may cause the boiler to vibrate considerably. Steam engines in which the governor and valve mechanism are not properly adjusted, are also subject to vibration.

General Arrangement of Steam Piping

No general rule can be given for the general arrangement of steam lines in a steam power plant, as the conditions to be met vary greatly in different plants. The designer should aim to carry his mains as direct as possible and should avoid unnecessary pipes and fittings. The piping should contain as few joints as possible and should be so designed as to permit

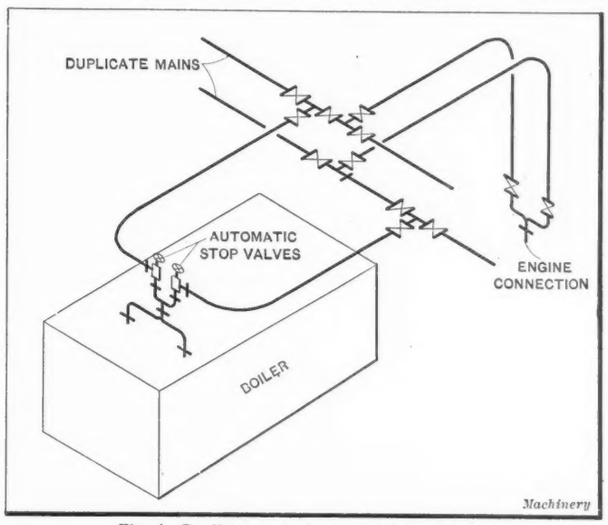


Fig. 4. Duplicate-main System of Steam Piping

of repairs being made to any disabled branch without interfering with the regular operation of the plant. The system should be properly protected by valves, so arranged that any disabled branch of the system may be cut out of service. The general arrangement of the power plant as a whole, depends to a large extent upon the design and arrangement of the steam piping system, just as the arrangement of the piping system depends upon the arrangement of the plant. Therefore, it is not advisable to finally locate or install any of the steam driven machinery without first giving due thought and attention to the arrangement of the main steam piping. The accompanying diagrammatic views illustrate several methods of arranging the boilers and engines in a steam power station, and the arrangement of the main steam piping suited to the conditions.

In Fig. 1 is shown the "ring main" system of steam piping. This system is readily adapted to power plants in which the boiler and engine rooms are placed end to end, as shown. The steam from the boilers passes to the engines through two main headers, one on each side of the building. These headers are connected at each end of the building as shown at *A* and *C*, the whole forming a complete ring of piping. In some cases it has been found advisable to cross-connect the ring system through an additional tie line, placed as shown at *B* to provide a better distribution of the steam. Valves are placed in the mains between each unit, so that any section of the main may be cut out of service by closing two of the valves in case of an accident occurring to any branch of the system. If, for example, the ring main failed at point *D*, the valves *E* and *F* could be closed, boiler No. 3 cut out of service, and the steam from the other five boilers carried around through the ring main to the engines as shown by the arrows.

In order to be effective, the ring main should be made full size throughout its entire length, and should be of sufficient area to supply all the engines in the plant. All valves in the main header should be kept open during operation. Where the boiler and engine rooms are placed end to end as shown in Fig. 1, a large quantity of piping material is required, and owing to the large area of radiating surface, the condensation

loss in the steam mains is quite considerable. If at any future date additional boiler and engine units are added to a plant of this type, the building must be extended at each end, as shown by the dotted lines, and the piping may be too small to accommodate the additional units.

The ring system of steam piping became quite popular some few years ago, especially in medium and large size plants where continuous operation and uninterrupted service are a necessity. In those days a poorer grade of piping material was in general use, and valves and fittings were not so well designed nor as reliable as they are to-day; as a result there was more danger of a "blow-out" in the piping system than there is at the present time. Owing to the large quantity of piping material necessary in a system of this kind, it is expensive in first cost, expensive to install, and expensive to keep in operation. There are a great many joints liable to leakage, a great many valves to be repacked and kept in repair, and the heat and condensation losses are excessive.

In Fig. 2 is shown another method of applying the loop or ring system of piping. In this case the boiler and engine rooms are placed side by side, with a division wall between them. Valves are located in the main header between each connection as in Fig. 1. As additional boiler and engine units are added to the plant, the building will be extended in the direction of the dotted lines.

In Fig. 3 is shown a more modern type of power station, in which the boilers and engines are placed back to back in separate buildings with a division wall between them. The main steam header consists of a single line of piping placed at the rear of the boilers. This header may be supported on brackets on the division wall, or suspended from the roof trusses overhead. With the boilers, engines, and piping arranged as shown, the flow of steam is direct from the boilers to the engines, and the main steam header may be made considerably smaller in size than in either of the previous cases, where the header must necessarily be large enough to pass the steam from all of the boilers in order to be effective. In fact, with the system shown in Fig. 3, the main header need be but little, if any, larger than the largest branch leading from it, as the piping is so arranged that the boilers feed the main steam header uniformly, or nearly so, throughout its length, and the engines are fed in a similar manner. The station is divided into complete and independent units, as it were, by placing gate valves in the main header between each connection. The valves are so placed that any section of the header may be cut out of service for repairs when necessary, or by closing the valves in the main header each unit may be made entirely independent of the others.

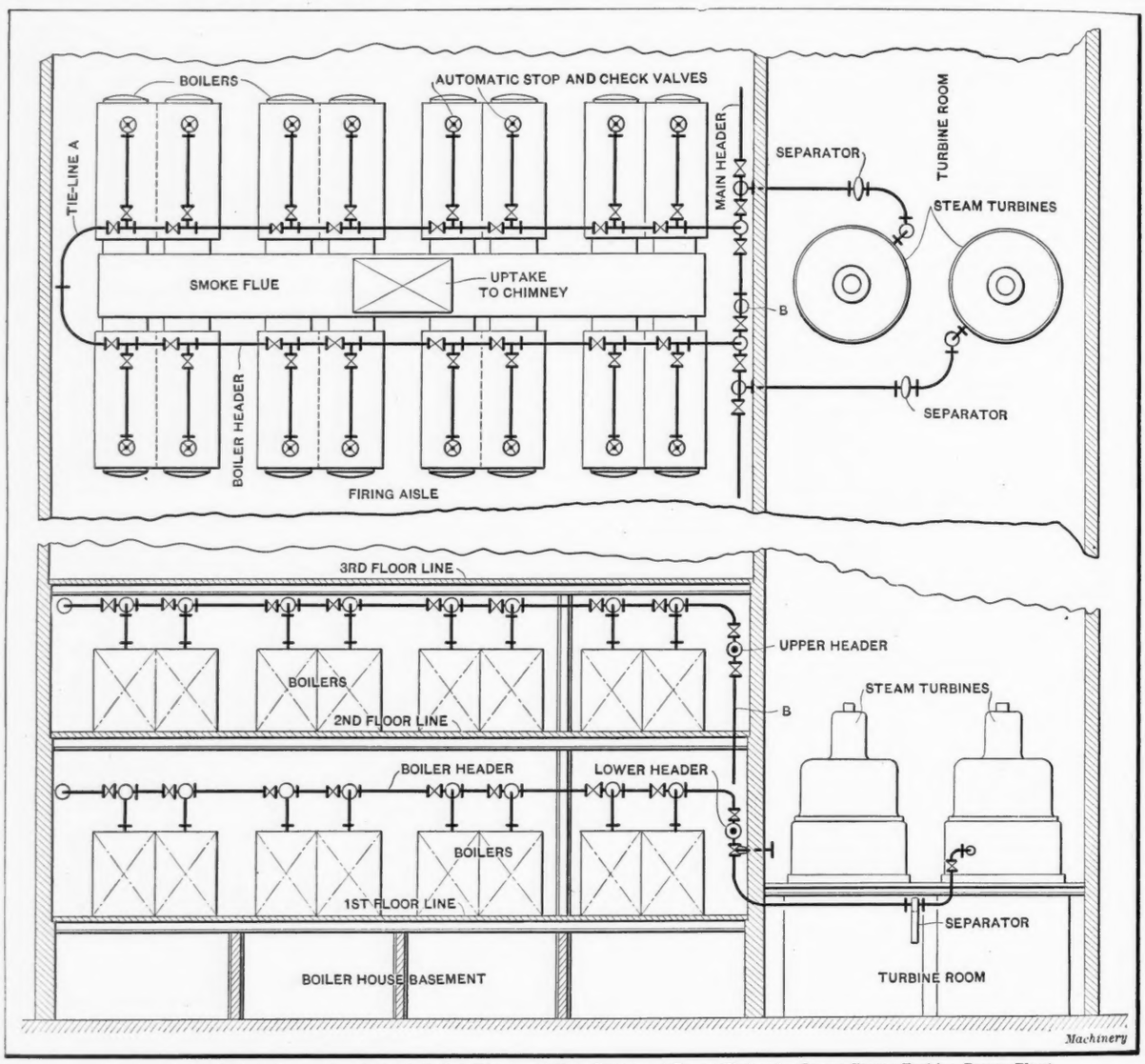


Fig. 5. Plan and Elevation of Double-deck Boiler House and Unit System of Steam Piping for Large Steam Turbine Power Plant

This system is generally used in present-day practice in preference to the ring system. It is cheaper to install as there are considerably less piping material, valves and fittings required, the piping is smaller in size, less pipe covering is required, and the steam flow is more direct than in any other system. Smaller pipe sizes and shorter mains expose considerably less radiating surface, and as a result the condensation losses are reduced. The dotted lines show how the building may be extended when additional boilers and engines are added to the station, in which case it is only necessary to extend the main header the desired length, keeping the size the same throughout.

In Fig. 4 is shown one unit of the duplicate-main system of steam piping. In this case the piping is arranged as in Fig. 3, except that the main header, and the branches from each boiler and to each engine, are in duplicate. Each main header is supplied by a separate boiler connection, and each engine supply pipe is connected to both headers. Two automatic stop valves are shown at each boiler, but, if so desired, only one need be used, with two branches leading from it, one to each main. This elaborate and costly system of piping is gradually losing favor and is seldom used in present-day practice. The duplicate-main system was introduced some years ago in order to insure greater reliability. Manufacturers are now, however, meeting the demand for a first-class single-main system by supplying a better grade of material and better workmanship. As a consequence, duplicate mains and ring mains are rapidly becoming relics of the past. Reliability is better assured by the careful design of valves, fittings, and flanged connections, by the judicious placing of cut-out and by-pass valves, and by properly providing for expansion ond contraction, as well as by the use of steel pipe bends of long radius in preference to the short radius, cast elbows. The locating of the drip pockets and separators in the line where they will do the most good, and the trapping of all water of condensation back to the boiler as fast as it forms, will result in a single piping system far superior to the elaborate and expensive duplication of the past.

Double-deck Boiler Plants

In large central power plants it frequently happens that sufficient ground space is not available to accommodate all the boilers on one floor, in which case the boilers are placed on two floors as shown in Fig. 5. In this case the boilers and steam turbines are placed in separate buildings. For convenience only part of the station is shown; *i. e.*, two complete units. Each turbine unit requires 16 boilers for its operation, as shown in the plan view, and these boilers are placed on two floors. The boilers on each floor discharge to a common ring main at the rear of the boilers. This main is tied together at one end by tie-line *A*, and at the other end through the main header. This main header is carried on the division wall. There are two main headers, one on each floor; these are tied together at certain intervals through tie-lines *B*. Thus the steam from the upper boilers is discharged into the upper header, and from thence to the lower header, from where it is distributed to the steam turbines, as shown in plan and elevation. Valves are placed in the headers between each connection so that any damaged section may be cut out of service without crippling the station.

This station is arranged on what is known as the "unit system," under which each prime mover has its own complement of boilers, separately connected, and cross-connected from one to the other through the main headers. By dividing the station into units, the operating force may be divided into crews, each crew taking care of one or more units, depending upon the size of the station. With the unit system, boiler and engine tests may be run on any one unit without interfering with the operation of the other units, and any one unit may be put in or taken out of service as desired. The piping for the different units being cross-connected through the main headers, makes it possible to switch the load over from one prime mover to another in case of an accident, without changing from one set of boilers to another.

In order to guard against any possible damage to the electrical apparatus due to a ruptured or exploding steam main, the main header and as much of the steam piping as can be so arranged, should be placed in the boiler room. In this case, should a blow-out occur, doors may be closed between the boiler room and engine room, thus protecting the electrical apparatus from damage. After the steam pressure falls sufficiently in the boiler room, the damaged section may be cut out of service, and the balance of the plant may be operated while repairs are being made. Should the blow-out occur in the engine room, however, it might be necessary to shut down the plant for several days on account of the damage to the electrical apparatus.

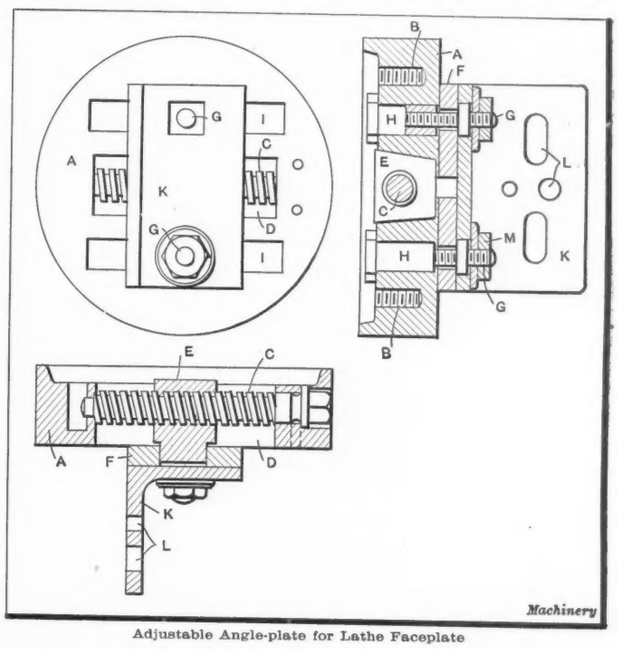
All the boilers in a steam power plant should be protected by automatic stop and check valves, placed in the steam line at the outlet of each boiler. Then, should a tube burst in any of the boilers, the automatic stop valve will close when the pressure falls, preventing the steam from the other boilers from flowing into the damaged one and out through the ruptured tube. If these valves are arranged to work in both directions they will shut down the boilers automatically in case the header explodes, preventing the steam from all of the boilers emptying through the damaged main.

In the piping systems just described, valves are shown in the main header between each connection to and from the header. This provides a well protected system of piping. Valves are quite expensive, however, and for this reason they are frequently omitted in the main header. In some cases the designer compromises by placing valves only between every second or third unit; this, of course, is a question to be decided in each individual case.

* * *

ADJUSTABLE ANGLE-PLATE FOR LATHE FACEPLATE

The accompanying engraving, reproduced from *Engineering* (London), shows an appliance that has been devised for mounting work on the lathe faceplate. It consists of an angle-plate which is adjustable by means of a screw across the faceplate. The screw does not carry the weight of the angle-plate and the work attached to it, but is merely used for adjustment. When the work has been adjusted to the position required, the angle-plate is clamped firmly to the main portion of the attachment. The engraving shows a plan view and



Adjustable Angle-plate for Lathe Faceplate

sections. The device consists of a plate *A* which has two or more screw holes *B*, by means of which it is attached to the faceplate of the lathe. The adjusting screw is shown at *C* and is carried in bearings at opposite ends of the slot *D*. The sliding block *E* is provided with a projection which fits into an opening in the sliding intermediate plate *F*. This latter is attached to plate *A* by screws *G*. The ends of these screws are threaded into rectangular sleeves *H*, with flanges on their outer ends. These sleeves work in slots *I*, as shown. The angle-plate *K* has holes in it which receive the square collars on bolts *G*, thus preventing the latter from turning. Holes *L* are provided for attaching the piece to be machined to the angle-plate.

* * *

A chrome-vanadium crankshaft, weighing only 61 pounds but of 125 horsepower capacity, was recently turned out by the Bourne-Fuller Co. of Cleveland, for the Roberts Motor Co., of Sandusky, Ohio. The crankshaft is 76 3/16 inches long, 3½ inches outside diameter, and is bored to 3⅛ inches inside diameter throughout its length except at the tapered ends. The rough shaft weighed about 250 pounds.

DIMENSIONS OF TAPER KEYS AND KEYWAYS*†

BY G. G. DANA‡

The establishment of a practical and accurate method of dimensioning keyways on drawings is a problem with which many draftsmen have undoubtedly been confronted. The writer, having used the customary method of dimensioning and noted its shortcomings in shop work for a number of years, has originated a method of dimensioning on the drawings which meets the requirements of the shop and reduces to a minimum the cost of fitting keys, at the same time insuring a better grade of work.

The method formerly used was to give the depth of the keyway at the side, that is, from the corner to the bottom, as shown in Fig. 1, the dimension *B*, in the hub, being given at the thick end of the key. The principal objections to this method were that the machinist could not measure the depth *A* accurately on account of burrs that would be raised at the corner in cutting the keyway; nor could he measure at *B* if the hub was made of cast iron, on account of the corners being ragged and broken. The hub in some instances was not machined on the end, where the dimension *B* was to be measured; hence there was no definite point from which to measure. No two machinists would read a scale alike in taking measurements under these conditions. A micrometer could not be used, so the result was that an unnecessary amount of stock had to be left on the thickness of the key, to be taken off when the key was fitted, on account of the variations due to the impossibility of accurate measurements being taken by the machinist.

The new method of dimensioning keyways overcomes all of these objections and makes it possible for the machinist to use calipers, micrometers or gages for all measurements. The depth of the keyway in the hub is given at the thin end of the key, and the measurement is taken from the opposite side of the hole as shown at *H*, in Fig. 3, while the

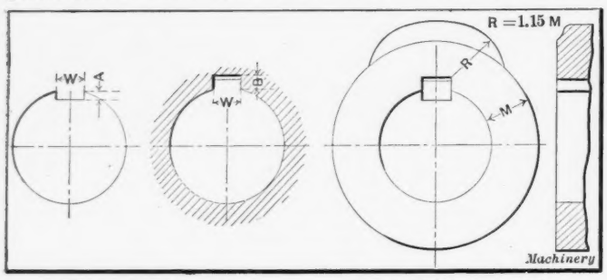


Fig. 1. Usual Method of dimensioning Keyways

Fig. 2. Reinforcements for Hubs over Keyways

depth of the seat in the shaft is measured from the opposite side of the shaft to the bottom of the keyway, as shown at *S*. The width of the keyway in the shaft and hub is given in the usual way. It will readily be seen that by taking the dimensions from the opposite side of the shaft or hole, there is no excuse for inaccurate work. These surfaces must come together when the key is driven in. In the event that the turning or boring is not accurately done, it will not affect the fit of the key. The allowance of stock to be left on the key for fitting can be reduced to a minimum; not over 0.003 inch is allowed when the machining is done by fairly accurate workmen.

Since, in the majority of cases, the hubs of the keyed parts are faced on the side running against a bearing or other machine part, and as this end of the hub usually carries the thin end of the key, it was decided to establish the system on this basis. By using the thin end of the key as a basis, there is no necessity of varying the standard when a very long hub is used; the depth simply increases in the hub as the length of hub is increased. With the old method of measuring from the thick end of the key, the depth in the hub would decrease, so that with long keys a variation from the standard had to be made to avoid too shallow a keyway in the hub at the thin end of the key.

The following rules for the proportions of keys were used: Width of key equals the adopted fractional size nearest to one-fourth of the diameter of the shaft; thickness of key at thin end equals three-fourths of width; the taper of the key is ⅛ inch in 12 inches. Keys 1 inch wide and wider are made thinner than the above rule calls for. The width of key is made to vary by 1/16 inch until 3/4 inch is reached, then by ⅛ inch increments until 1¼ inch is reached, after which the advance is made by ¼ inch. The depth in the hub and shaft are made approximately equal at the thin end of the key, this depth being taken at the side of key. This allows the increase of thickness due to the taper to come in

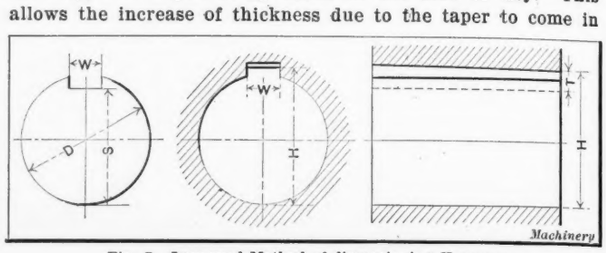


Fig. 3. Improved Method of dimensioning Keyways

the hub, which is usually of a weaker material than the shaft; thus the greater bearing surface at the side of the key will, in a measure, compensate for the difference in strength of the materials. On specially heavy work, or where the hubs are proportionately short, it is advisable to use two keys set 90 degrees apart.

The correct dimensions for *H* and *S*, as shown in Fig. 3, may be arrived at by mathematical calculation, or, perhaps more quickly and with sufficient accuracy, by graphical layouts to an enlarged scale. The latter method was the one pursued in obtaining the figures in the accompanying Data Sheets. In order to give the dimensions in even sixty-fourths of an inch, the depth in the hub was increased.

In deciding upon the reinforcement over the keyway many draftsmen and designers do not follow any systematic rule. It is evident that the strength of the hub at the keyway should be at least equal to that of any other part of the hub. In addition to the equal strength, there should be extra strength on account of the localized strains due to the force exerted by the key against the side of the keyway in transmitting the power, and also due to the wedging action of driving the key, which has a tendency to crack the hub at the corners of the keyway. The metal surrounding the key, then, should be thicker than that in the body of the hub by an amount equal to from 10 to 20 per cent, or, for average practice, 1.15 times the thickness of the body of the hub. The reinforcement should not extend to the extreme end of a hub which is faced, as this would add to the machining work, but would add nothing to the strength. Referring to Fig. 2, if *M* is the thickness of the metal in the body of the hub, then the reinforcement for the key should be laid out as shown, with the radius *R* taken from the corner of the keyway, the length of *R* being 1.15 *M*.

The thickness of the metal in the hub may vary to conform to the nature of the work done by the pulley, gear or sprocket, but for average practice a good proportion for the metal in the hub is 0.45 of the diameter of the shaft for small shafts, say up to 1½ inch diameter, and about 0.35 for shafts of larger sizes, say 5 inches diameter and up. The designer must, of course, exercise his judgment to a great extent, and vary the proportions to suit the nature of the work, the length of the hub, and other factors which tend to modify the design.

* * *

During the year 1912, 2997 miles of new railway tracks were built, and 226,195 freight cars, 3623 passenger cars and 4424 locomotives were ordered. The number of freight cars ordered in 1912 was nearly double the number ordered in 1911, which was only 133,117. The number of passenger cars ordered in 1911 was 2623 and of locomotives, 2850.

*With Data Sheet Supplement.

†The following articles dealing with this and kindred subjects have previously been published in MACHINERY: "The Effect of Keyways on the Strength of Shafts," January, 1911, engineering edition; "Keyway Gaging in Shafts and Hubs," December, 1908; "Device for Laying Out and Testing Keyways," March, 1908; "Keys and Keyways," March, 1907, engineering edition; "Measuring Keyways," October, 1906; "Notes on Keys and Keyways," September, 1901. See also MACHINERY'S Reference Series Book No. 22, "Calculations of Elements of Machine Design," Chapter VI. "Keys and Keyways;" and MACHINERY'S Data Sheet Book No. 7, "Shafting, Keys and Keyways," pages 32 to 40 inclusive.

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KEYSEATING AND PLANING FIXTURES

A keyseating fixture of simple design and which can be applied to a shaper, is shown in Fig. 1. This device was made by the R. A. Kelly Co., Xenia, Ohio, for keyseating gears and pulleys, and is shown in the illustration attached to a 20-inch Kelly back-geared crank shaper. The fixture consists mainly of a cast-iron bracket *A* provided with two legs which are bolted to the base of the shaper column, and having a boss at its upper end bored to suit the tool bar *B*. This bar is threaded on its rear end and is screwed into the hole ordinarily occupied by the screw holding the clapper-box holder, which is removed. A keyseating cutter is held in the bar *B*, which is moved back and forth by the shaper ram.

The work to be keyseated is held in the shaper vise in the usual manner. The feed for the keyseating is obtained either by hand or by the power elevating feed, the table being raised a slight amount for each stroke of the ram. To resist the thrust of the cut and prevent any binding action of the bar in the hole in the bracket, the latter is supported by straps *C* which are fastened by cap-screws to the top of the bracket and to the ways of the machine.

Fig. 2 shows a planer fixture in use in the shops of the R. A. Kelly Co., for planing five shaper vise jaws at one setting in a 30 by 30-inch Gray planer. The fixture used consists of a cast-iron strip *A* which is provided with projections planed to suit the shape of the bases of the vise jaws *B*. The dovetailed portions of the jaws are held against corresponding faces on the fixture by set-screws held in blocks which are provided with shanks fitting in holes in the planer fixture. The jaws *B* are held down on the fixture by five straps *C* and bolts, as shown. In this fixture, only those faces on the top of the cast-iron base against which the steel jaws are held, are machined.

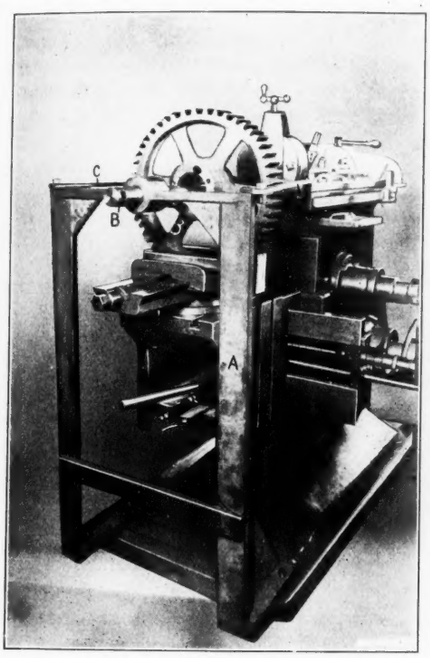

Fig. 1. Simple Keyseating Fixture for Shaper

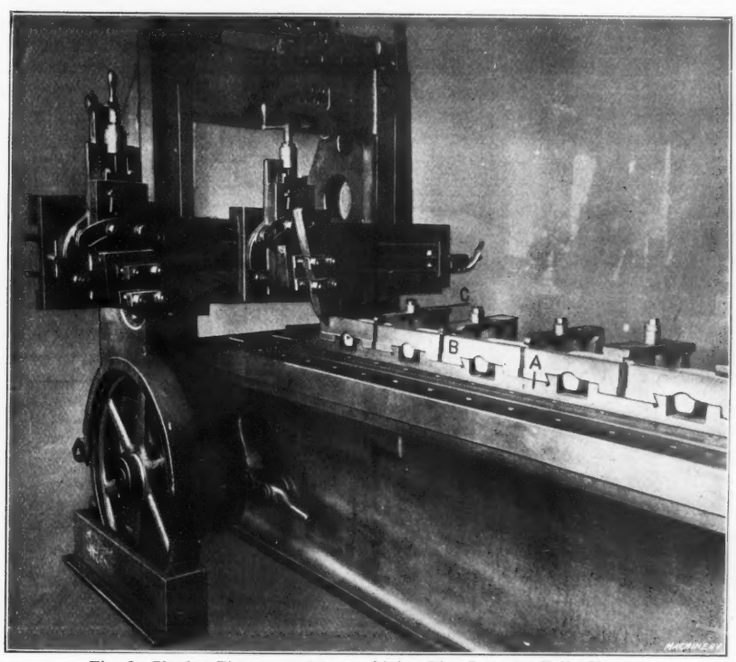

Fig. 2. Planing Fixture used in machining Vise Jaws for Kelly Shapers

Particular care was taken in planing this fixture to have the projections against which the vise jaws are held at right angles to the tongues formed on the base of the fixture and fitting in the grooves in the planer table, so that the faces of the jaws would be square with the vees. It is evident that the use of this fixture simplifies the planing of these jaws to a marked degree, and makes possible the interchangeability of the parts. D. T. H.

* * *

The International Aluminum Syndicate has fixed the price for the metal for 1913 at 160 marks per 100 kilograms, equivalent to about 17.5 cents a pound. It is generally believed, however, that the production during the next ten months will not be able to keep pace with the consumption, and that a higher price will prevail towards the end of the year.

TOOLS FOR MULTIPLE PLUNGER PRESSES*

BY CHARLES DOESCHER†

The multiple plunger press has become a most important factor in the economical manufacture of articles from sheet metal. In the following, the writer will describe the construction and use of the punches and dies as applied to this type of press. It should be stated in the beginning that multiple plunger presses are used for both large and small work; the presses for the large sizes of work are necessarily of a stronger and more massive type of construction than those that are used for smaller work. The tools illustrated and described in this article are used for the smaller classes of work. The method of transferring the work from one plunger to another was described by the writer in the August, 1911, issue of MACHINERY, so that it will not be necessary to again go into details regarding this part of the work. A brief description of the punches and dies and the manner in which the work is made complete from the sheet metal will, however, be given.

Preparation for Making the Tools

Before going into details concerning the construction of the punches and dies used in multiple plunger presses, it may be well to lay stress upon the fact that, preparatory to constructing the tools, one of the first things to do is to make sure that the construction of the press is such that the tools will not only be interchangeable in a given press, but also with the tools in other presses. In trying out a new set of tools, it is often found that better results are obtained by changing the sequence of some of the operations; for instance, we will say plunger No. 2 does the cupping, No. 3 the forming, No. 4 the piercing, etc. It often happens that some of these operations must be reversed, and if the tools are interchangeable, this can be done without any extra time being spent in altering the length of the punches, or in making new ejecting pins to fit the press. Then, again, if the tools for different presses are not interchangeable, they can only be set up and run in the press for which they were originally made; this means that there are often times when some of these presses will be out of use, simply because there are no orders for work which calls for the use of the tools that were made for the "dead" machine in question. On the other hand, there may be orders for work which must necessarily wait until another job has been run through on a given press that is in use, because the tools to be used were made for the press that is

* For additional information on this subject, see "The Multiple Plunger Press," by Charles Doescher, in the August, 1911, issue of MACHINERY.

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already in use, and are not interchangeable. This deplorable condition actually exists in some shops. The fact must be taken into consideration that the taper wedges used for adjusting the stroke of the plungers afford only 3/16 inch adjustment, and unless the presses are made so that the tools are interchangeable, the loss of time due to having "dead" machines is bound to occur again and again.

In adjusting a multiple plunger press to insure interchangeability, the first thing to do is to regulate the taper wedges used for adjusting the stroke of the plungers, so that they will all be in the same relation to each other. The press

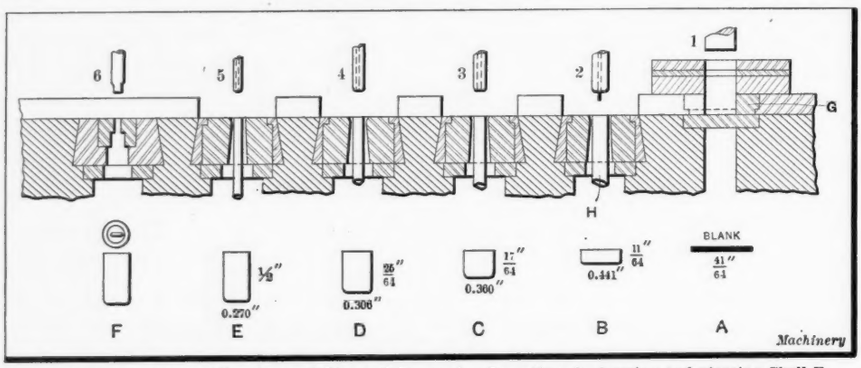


Fig. 1. Construction of Punches and Dies and Successive Operations in drawing and piercing Shell F

is then given a half turn, so that all the plungers except plunger No. 1 are down as far as they will go, so that the distance from the top of the die bed to the face of the respective plungers can readily be measured. It seems hardly necessary to say that this distance must measure the same in each case. The same can also be said of the face of the knock-up plungers which, when raised up as far as they will go, must all measure the same distance to the top of the die bed. The depth of the ejecting pin holes in these plungers must also be the same, as, on small work, the ejecting pins rest on the bottom of these holes; and it is therefore essential that the depth of the respective holes be the same if the ejecting pins are to be interchangeable. It is also important to have the holes for the dies in the dovetail die-holders perfectly central with the threaded holes in the plungers, and also bored out to fit plug standards, so that there will be interchangeability so far as the various dies and die-holders are concerned.

An Example of Shell Work done on Multiple Plunger Press

Fig. 1 shows a set of tools for a six-plunger press used in making the shell which is shown completed at *F*. The diameter of this shell is 0.270 inch, the length is ½ inch, and it

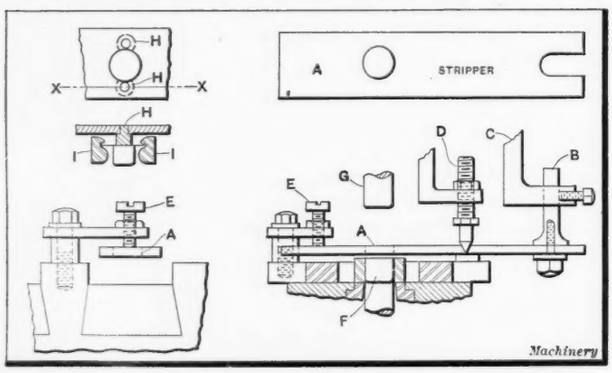


Fig. 2. Stationary Stripper and Method of securing it to the Press

has a small elongated slot pierced out of the bottom. The metal is first fed between the guide plates, where the round blank *A* is punched out and forced into the nest *G* in the transfer slide by the blanking punch in plunger No. 1, the nest being made to fit the blank tight enough to retain it. The blank is then carried under the drawing punch held in plunger No. 2 and drawn up into the shell shown at *B*. The punch is made small enough so that it will just draw up the shell and keep it from wrinkling, thereby preventing the metal from becoming too hard to be successfully worked in the following operations. After the shell is drawn up, it is ejected from the die by the ejecting pin *H* and then forced between the fingers in the transfer slide. These fingers hold the shell in place while it is being carried under plunger No. 3. As the shell *B* does not hug the punch tightly, no stripper is necessary; the push-pin prevents the shell from clinging to the punch. When the shell *B* comes under plunger No. 3, it is redrawn to the shape and size shown at *C*, care being taken to have the redrawing punch small enough so that it will not pinch the metal any harder than is absolutely necessary. The same can also be said with reference to the following drawing operations, except the one done under plunger No. 5, which draws the shell *E* hard. The last operation is piercing out the narrow slot in the bottom of the shell, which is done by the piercing punch held in plunger No. 6 and the piercing die shown directly underneath it. The finished shell is then pushed from the press into a pan or box by a push-finger held in the transfer slide. It will be seen that no ejecting pin is used in this operation, as the shell rests on the top of the piercing die while being pierced, and therefore the knock-up plunger can be removed in order to allow the scrap punchings to escape. In stripping the shell from the punches in the third, fourth, fifth and sixth operations, stationary strippers similar to the one shown in Fig. 2 are used.

Stripping the Work from the Punches

For the punches and dies used in a multiple plunger press, two forms of strippers are generally used. One of these strippers is known as the stationary stripper, while the other

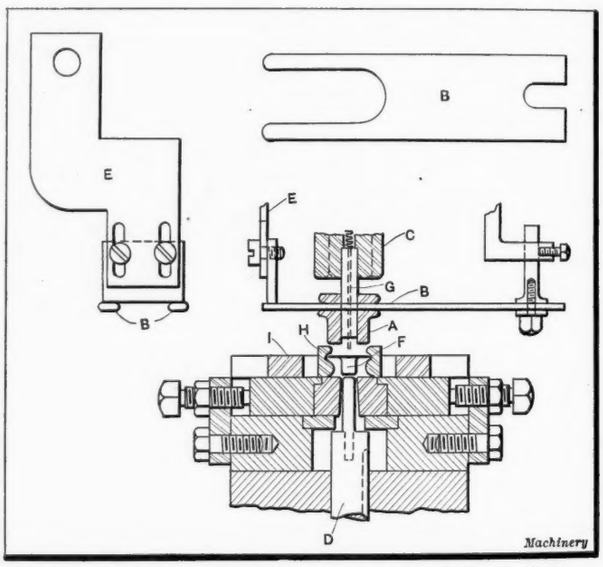


Fig. 3. The Use of a Traveling Stripper on a Multiple Plunger Press

is called a traveling stripper and is used in connection with a thimble for stripping the work from the punches. Fig. 2 shows the stationary stripper *A* held in position by the stud *B*, which, in turn, is held by a bracket *C* fastened to the rear of the press. The stripper has an elongated slot in one end to provide for adjustment. In addition to the stud *B*, the stripper is supported by the pointed screw *D* and the screw *E*, which are placed on each side of the hole used for stripping the shell *F* from the punch *G*. These screws, as well as the stud *B*, can be adjusted to different heights to accommodate different lengths of shells. The pointed end of the screw *D* rests in a small countersunk hole in the stripper; this not only helps to stiffen the stripper but also tends to prevent it from shifting endways. Fig. 2 illustrates the manner in which the stripper strips the shell shown directly underneath it. The device used for stripping flanged shells from the punch with a stationary stripper is shown in the

upper left-hand view. Two short shouldered pins *H* strip the work from the punch, so that the flanged part of the shell can be readily grasped and retained in the circular grooves in the fingers *I*, as shown. These pins are made small and placed in the center of the open space between the fingers so that the projecting pins will clear the fingers and not interfere with their free action. The sectional view of this stripper is on the line *X–X*.

Fig. 3 shows the manner in which a traveling stripper is used in the multiple plunger press for stripping the work from the punches. The punch is made a sliding fit in the stripping thimble *A*, which has a circular groove that engages in the forked part of the traveling stripper *B;* this thimble is also used in forming up flanged shells, as the face of the punch-holder *C* forces the thimble down on the flange and keeps it flat, thus preventing the work from getting out of shape. Making use of the stripper thimble in this manner, does away with the necessity of using a solid shouldered punch; and as these thimbles can be used over and over again, they effect quite a saving. When in operation, the thimble is forced downward by the punch-holder; on the upward stroke of the press the traveling stripper, which acts in the capacity of a flat spring, forces the thimble upward with the assistance of the knock-up plunger *D*. When the fork of the stripper comes in contact with the adjustable stop *E*, as shown, it affords a substantial stripping arrangement for stripping the shell *F* from the punch. The stop *E* is fastened to the front of the press, and is made adjustable to allow for different lengths of shells, in order that the shells can be stripped from the punches at the right time on the upward stroke of the press. The punch is made slightly tapering so that the shells can be readily pushed off by the push-pin *G* and grasped by the fingers *H* in the transfer slide *I*.

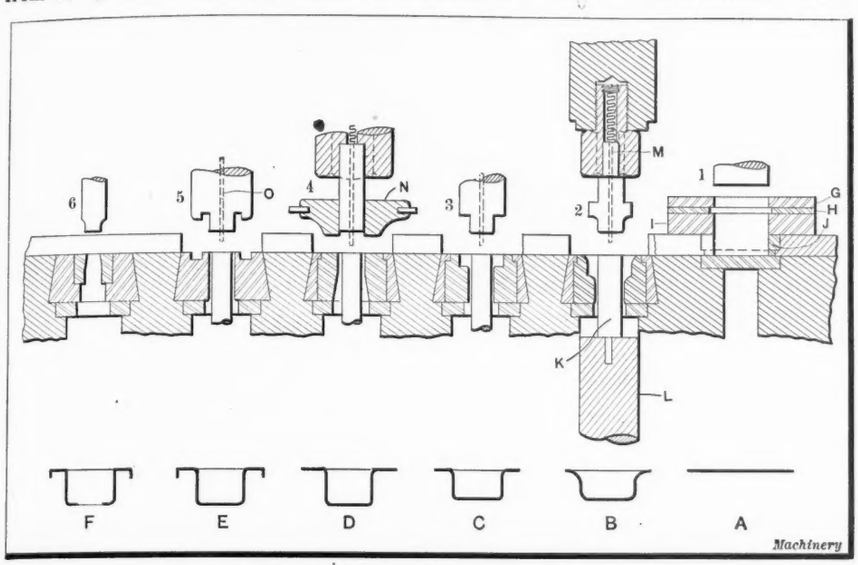


Fig. 4. An Example of Flanged Work formed on Six-plunger Press

Another Interesting Example of Shell Work

Another interesting example of shell work, as performed on the multiple plunger press, is shown in Fig. 4. These tools complete the shell shown at *F* in six operations, their construction and operation being somewhat similar to the tools described in connection with Fig. 1. The metal is fed under stripper *G* in the usual way, and guided by the plates *H*. *I* is the blanking die and *J* the nest in the transfer slide for carrying the blank under plunger No. 2, where it is forced into the die and cupped up as shown at *B*. In this operation no blank-holder is used to prevent the blank from puckering while it is being drawn up. On the downward stroke of the press, the cupping punch forces the blank and the ejecting pin *K* downward. As the knock-up plunger *L* which holds the ejecting pin in place is held up by spring tension, the blank is prevented from shifting and is held central while being cupped up. The blank is first partly cupped by the round corners shown on the top of the die, after which it is drawn up into the desired shape by the lower shoulders on the die. On the upward stroke of the press, the ejecting pin forces the cupped shell out of the die into the fingers of the transfer slide. No stripper is required, as the metal is not pinched hard by the punch, and the shell therefore does not hug the punch. The push-pin *M* merely prevents the shell from clinging to the punch on account of any settlement of oil in the bottom of the shell. In cupping up the shell in the manner previously described, it should be stated that a clean cut blank must be used which is free from all burrs—otherwise the shell will pucker and wrinkle while being drawn into shape, inasmuch as no blank-holder is used, as previously stated.

After the shell is cupped, it is transferred under punch No. 3, where it is drawn up and flanged as shown at *C*. Punch No. 4, with the aid of the thimble *N*, draws the barrel part of the shell smaller and longer, as shown at *D*, while punch No 5 acts upon the flanged part of the shell only, and forms it into the shape shown at *E*. The teat of this punch is made a sliding fit in the barrel part of the shell and guides it into the die. As the shell does not hug the punch, no stripper is necessary; the push-pin *O* prevents the shell from remaining on the punch. The last operation is to pierce out the ¼-hole in the bottom of the shell, shown at *F;* this is done by punch No. 6, after which the finished shell is stripped from the piercing punch by a stationary stripper. The work is then either blown out of the way by compressed air, or pushed off the press by a push-finger, and drops into a box under the press.

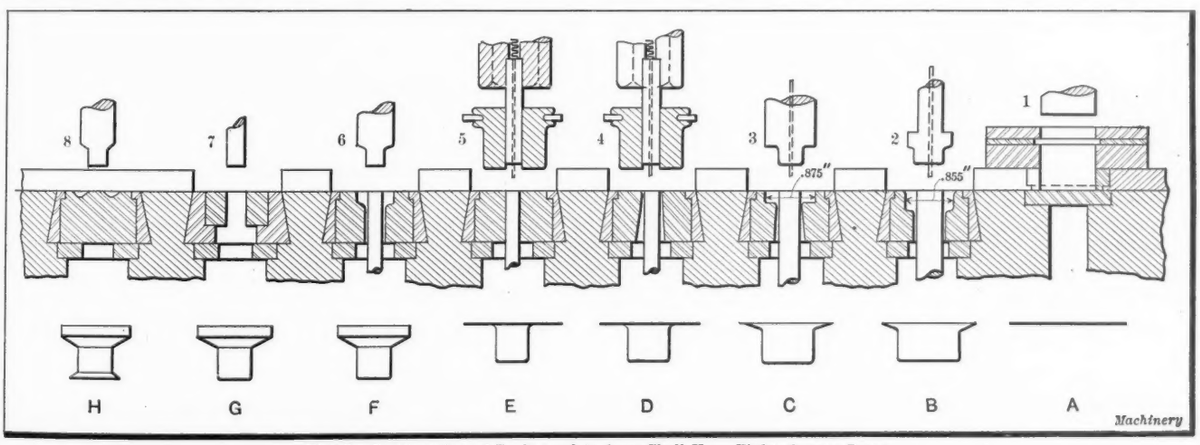


Fig. 5. Construction of Tools used to form Shell H on Eight-plunger Press

Example of Shell Work performed on Eight-plunger Press

Fig. 5 shows a most interesting set of tools for making the shell shown at *H* complete from sheet metal on an eight-plunger press. The tools shown in Fig. 5 are made and operated in the same manner as those already described and therefore require very little explanation. The illustrations show the progress of each operation very clearly, as the shell is carried from one punch to the other. To be brief, the blank *A* is cut from the metal, carried under punch No. 2 and cupped up in the usual way. The cupped shell *B* is then transferred and gradually drawn up into a flanged shell as shown at *C*, *D* and *E*. In drawing up the shell to the form shown at *D* and *E*, the usual stripping thimbles are used in connection with traveling strippers. On the next operation, punch No. 6 cups the flanged part of the shell into the shape shown at *F*. The teat of punch No. 6 next engages the inside of the shell and forces it into the die. As the shell is drawn into the die, the flanged part is cupped up while being drawn over the corner of the die which is slightly rounded, after which it is formed into the desired shape by the beveled shoulder of the die. Punch No. 7 pierces the bottom of the shell; the shell is then stripped from the punch by the stationary stripper. On the last operation, the bottom end of the shell is flared outward, as shown at *H*, by being forced over the short tapered teat shown in the center of the die. The shell is then stripped from the punch and drops into a box under the press.

* * *

STEEL BELTING FOR POWER TRANSMISSION

The use of steel belts in some of the large manufacturing establishments of Huddersfield during the past year has been most satisfactory, states U. S. Consul Franklin D. Hale of Huddersfield, England. At a local mill a steel belt 7⅞ inches wide, weighing 119 pounds, performs the work formerly done by a leather belt 22 inches wide, weighing 814 pounds, driving 300 horsepower. In another mill a steel belt 3½ inches wide, weighing 12 pounds, does work in driving 40 horsepower that formerly required a leather belt 12 inches wide, weighing 64 pounds. This is especially appreciated here in the woolen industry, where steadiness and uniform speed are essential to the best results. The steel belt is also an economizer of space, does not slip or stretch, and gives the greatest efficiency of power delivery. A government test has shown a saving of 61 horsepower on a drive of 640 horsepower in using the steel belt. Wooden pulleys grooved for rope drive need not be discarded in changing to the metal belts, for the former can be easily, and at small cost, converted into serviceable ones for steel belts by stretching a steel band over the top of the grooves, thus obtaining a flat pulley.

* * *

An interesting method for heating a building has been adopted by the Moline Automobile Co., Moline, Ill., in its chassis assembling department. This building is heated by means of steam pipes embedded in the concrete floor. The structure is 120 feet long by 60 feet wide and has door openings extending completely across the ends of the building. As the workmen are obliged to frequently lie on the floor in making necessary repairs and adjustments, it was decided to keep the floor surface comfortably warm; hence 1¼-inch steam pipes spaced 42 inches apart are installed 2 inches below the surface of the 6-inch floor. The concrete is reinforced locally against cracking due to the expansion of the steam pipes by corrugated iron pipes enclosing the former. It is stated that by using only five small ordinary radiators in addition to this heating system, it is possible to maintain a uniform temperature of from 65 to 70 degrees F. throughout the building.

* * *

It is stated that the barbers in the Calumet region have an experience of their own with Portland cement. The barbers claim that the dust in the cement plants in these districts settles in the men's beards, and that after having been moistened with perspiration it sets hard, forming, in combination with the beard, a good reinforced concrete that takes the edge off the razors. Here is an opportunity for a prolific inventor to produce a tonsorial sand blast.

PROPORTIONS FOR ROLLING MILL FILLINGS OR DETAILS

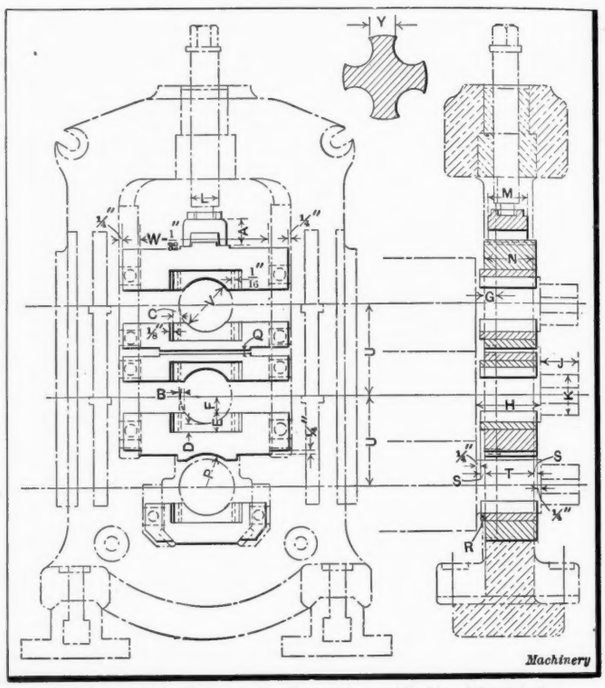
BY R. H. CREVOISIE*

The accompanying illustration and the formulas give proportions for mill fillings. Assume that U equals the unit pitch diameter of the rolls; then referring to the illustration:

$A = U \times 0.3$	$L = U \times 0.3$
$B = U \times 0.075$ to $U \times 0.1$	$M = L + 2$ inches
$C = U \times 0.1$ to $U \times 0.125$	$N = U \times 0.6$
$D = U \times 0.075$	$P = \frac{1}{2}V + \frac{3}{4}$ to $1\frac{1}{2}$ inch
$E = U \times 0.25$	$Q = \frac{1}{4}$ inch minimum
$F = (V \div 2) + D - E$	$R =$ from $\frac{1}{4}$ to $\frac{1}{2}$ inch
$G = U \times 0.16$	$S = U \times 0.05$
$H = (U \times 0.55) + 2S + \frac{1}{2}$ in.	$T = U \times 0.55$
$J = U \times 0.4$ to $U \times 0.5$	$V = U \times 0.6$
$K = U \times 0.55$ to $U \times 0.65$	$W = U \times 1.3$

Make pitch of Acme thread on screws equal to $U \times 0.05$.

When capped housings are used, two bolts should be employed, square in housing for key, and round in cap.



Notation used in Formulas for Proportions of Rolling Mill Details

The wabbler on the rolls and spindles is usually made with four jaws, as shown in the detail view at the top of the illustration. Dimension $Y = V \div 4$.

The diameter of the bolts $= U \times 0.19$ to $U \times 0.20$.

Outside diameter of spindles $= U \times 0.55$ to $U \times 0.65$.

Length of wabbler on roll $= U \times 0.4$ to $U \times 0.5$.

Outside diameter of coupling box $= U \times 0.9$.

The length of coupling box $= 2J$.

Allow ½ inch clearance between end of roll and end of spindle. Allow 3/16 inch clearance on radius between spindle and coupling box.

The boxes should be made of brass with babbitt set in pockets. The boxes are not finished. The carrier should be made of steel casting.

Face of pinions $= U \times 0.35$ to $U \times 0.5$ for each stand in the train. Use machine molded herringbone teeth and solid pinion boxes of steel casting with brass shell and babbitt strips. Allow ⅛ inch from the body of the pinion to the box in the pinion stand.

It is common practice to make the maximum peripheral speed of the finishing rolls 900 feet per minute.

In using the above formulas on fractional sizes less than 1 inch use the nearest larger sixteenth of an inch, and on sizes over 1 inch, use the nearest one-eighth.

*Address: Wickes Boiler Co., Canton, Ohio.

DESIGNING STEEL TOWERS FOR WOOD TANKS*—2

A COMPLETE ANALYSIS OF THE STRESSES IN THE TOWER STRUCTURE

BY EDMUND B. LA SALLE†

In the first article on this subject, the computations necessary for the determination of the stresses in the members of the tower frame were discussed. The present article applies the principles discussed to an example. We will consider a structure consisting of a medium sized tank and a tower of medium height. An outline of the methods used for finding the stresses in the structure and proportioning its members to sustain these stresses will be given; and this outline will be followed in illustrating the procedure in designing a tower. The principles applied in the present discussion were fully explained in the article published in the January issue of MACHINERY, and that article should be read as a preparation for what is to follow, especially by those not familiar with the subject. The following is an outline of computations necessary for determining the stresses in a four-post tower.

A. Dead Load in Post

The sum of the following gives the load on the posts: Weight of water, roof, tank, railing, balcony, floor system, and tower. The total weight of these items divided by 4 and multiplied by the secant of the batter of the posts (if any) gives the load in one post due to gravity. The secant for a batter of 1 inch per foot of column length is 1.00692. Multiplying the sum of the foregoing weights by 0.25173 gives the same result for a 1 inch batter.

B. Tank Wind Overturning Moment

1. Vertical projected area of the roof multiplied by the wind force per square foot determined according to either of the formulas previously given. 2. Vertical projected area of tank multiplied by 15. 3. Depth of cap beam multiplied by tank diameter, multiplied by 30. 4. The sum of these three results is the "tank wind." The tank wind multiplied by tank wind leverage gives the tank wind overturning moment.

C. Tower Wind Overturning Moment

1. Height of tower (length of posts) multiplied by the wind pressure per vertical foot gives the "tower wind." 2. Tower wind multiplied by half the tower height gives the tower wind overturning moment.

D. Stress in Post due to Tank Wind, and E, Stress in Post due to Tower Wind

$$\frac{B}{\text{Diagonal column centers}} = \text{stress in post due to tank wind overturning moment.}$$

$$\frac{C}{\text{Diagonal column centers}} = \text{stress in post due to tower wind overturning moment.}$$

D and E can be combined to obtain the stress due to the total wind load as follows:

$$\frac{B + C}{\text{Diagonal column centers}} = \text{stress in post due to total wind load.}$$

Diagonal column centers refers to the diagonal at the base of the tower or at the bottom of any panel under consideration.

F. Total Column Load, and G, Load in Anchor Rods

$A + D + E =$ total column load.

$$D + E - \frac{\text{Weight of structure—weight of water}}{4} = \text{load in anchor rods.}$$

H. Initial Load in Stress Diagram

This stress is obtained from the following formula:

$$\frac{\text{Tank wind}}{2} + \frac{\text{top panel wind}}{4} = \text{initial load in stress diagram.}$$

I. Load in Top Girt

The sum of the following gives the load in the top girt: weight of water, roof, tank, railing, balcony, and floor system. The sum of the preceding divided by 4, multiplied by the tangent of batter and added to H gives the load in the top girt. For towers with posts which batter 1 inch per foot of length, the load is given by the formula:

$$\frac{\text{Total weight in } A\text{—weight of tower}}{48} + H = \text{load in top girt.}$$

J. Wind Load Concentrated at Panel Points

The wind load concentrated at the panel points is found by multiplying the two panels adjacent to strut (or girt) by the wind force per foot of tower, and dividing the result by 4.

With this outline as a guide, we will take a 75-foot, four-post tower, supporting a wooden tank 20 feet in diameter by 20 feet high, and carry through all of the operations involved in its design. A 75-foot tower means a tower of sufficient height to raise the inside of the tank bottom 75 feet or, in other words, to give the lowest water line in the tank a 75-foot elevation.

Weight of Parts

By referring to the table of tank capacities, we find that a 20 by 20 foot tank contains 41,540 gallons. At 8.33 pounds per gallon, we have a water weight of 346,167 pounds. The table also gives the maximum weight of a cypress tank of this size as 19,200 pounds. No attempt will be made to tabulate the various weights of each item mentioned under A; therefore, the writer has made careful comparison of the data at his disposal and compiled a set of formulas which will give a close approximation of the various weights. We will take them in the order in which they were named in A.

TANKS WITH ROUND HOOPS MADE FROM THREE-INCH MATERIAL

Length Stave, Feet	Diameter		Hoops				Gross Capacity in Gallons	Pine, Weight	Cypress, Weight
	Feet	In.	¾-in.	⅞-in.	1-in.	1⅛-in.			
10	10	0	8	..	..	..	4750	3200	4200
12	10	0	10	..	..	..	5700	3700	4900
14	10	0	11	..	..	..	6680	4200	5600
10	12	0	9	..	..	..	7053	4000	5300
12	12	0	10	..	..	..	8488	4600	6000
14	12	0	12	..	..	..	9902	5200	6800
14	12	6	13	..	..	..	10798	5600	7200
14	14	0	14	..	..	..	13750	6500	8400
16	14	0	17	..	..	..	15701	7400	9600
14	15	0	14	..	..	..	15906	7000	9100
14	16	0	15	..	..	..	18229	7700	10000
16	16	0	5	11	..	..	20833	8900	11400
18	16	0	4	14	..	..	23406	9800	12600
14	17	0	16	..	..	..	20701	8400	10900
14	18	0	3	10	..	..	23340	8900	11600
16	18	0	4	12	..	..	26689	10200	13100
18	18	0	4	16	..	..	30004	11500	14700
18	18	6	4	16	..	..	31772	12100	15500
20	18	6	4	20	..	..	35285	13200	16800
16	19	2	4	13	..	..	30433	11200	14400
16	20	0	4	13	..	..	33270	11600	14900
16	20	8	4	13	..	..	35620	12400	15400
18	20	0	..	4	13	..	37423	13400	17100
20	20	0	..	4	18	..	41540	15200	19200
18	21	0	4	23	..	..	41428	14500	18500
14	22	0	4	11	..	..	35451	11800	15200
16	22	0	4	15	..	..	40576	13300	17000
16	22	3	..	15	..	..	40702	13600	17400
20	22	0	..	4	19	..	50687	17000	21500
24	22	0	..	4	28	..	61129	20900	26100
16	24	0	..	4	14	..	48606	15700	19900
16	24	6	..	4	14	..	50723	16200	20200
20	24	6	..	4	24	..	63884	20300	24800
18	26	0	..	4	17	..	64587	19200	24300
16	27	0	..	3	16	..	62006	18700	23700
18	28	3	..	4	19	..	76667	22000	27800
16	30	2	..	..	20	..	77926	22200	28000
20	30	.	..	..	4	22	96480	27800	34200
20	30	6	..	..	4	22	102669	28400	35000

Machinery

—From Catalogue of the U. S. Wind Engine & Pump Co., Batavia, Ill.

(Tank diameter)$^2 \times 11 =$ weight of roof for tanks 25 feet in diameter and larger.

* For further information on the design of steel towers for wood tanks, see the first installment of this article published in the January issue of MACHINERY; also "Double Angle Columns," published in the January, 1912, issue of MACHINERY.

† Address: 159 Harrison St., Batavia, Ill.

(Tank diameter)$^2 \times 12$ = weight of roof for tanks 24 feet in diameter and smaller.

Diameter of tank $\times$ 22 = weight of gas pipe hand railing.

Diameter of tank $\times$ 100 = weight of balcony or walkway.

Capacity of tank $\times$ 0.20 = weight of floor system.

Four-post Steel Towers

The weight of a tower depends a good deal on the designer. For the same capacity of tank, towers of different heights increase or decrease in weight in about direct proportion with the heights. For different capacities we strike another condition, and the only way to arrive at the approximate weight is by comparison with some previous design for the same capacity. The writer has fairly complete data on four-post steel towers for wooden tanks ranging from 10,000 to 50,000 gallons capacity, and from this data he has developed the following formulas:

For 50-foot towers to support tanks within the capacities named, the approximate weights are:

$$\text{Weight} = 15{,}800 - 9600\left(\frac{50{,}000 - C}{40{,}000}\right) \text{ pounds.}$$

For 75 foot towers,

$$\text{Weight} = 23{,}500 - 14{,}200\left(\frac{50{,}000 - C}{40{,}000}\right) \text{ pounds.}$$

For 100-foot towers,

$$\text{Weight} = 35{,}600 - 23{,}200\left(\frac{50{,}000 - C}{40{,}000}\right) \text{ pounds.}$$

C in each case is the capacity required in gallons.

For intermediate heights, the weights can be obtained by interpolation. It is a good plan to round off the weight by raising it to the next higher 1000 pounds. For tanks of 60,000 to 100,000 gallons capacity, a different style of construction must be used for the tower. For tank capacities up to 50,000 gallons, the cheapest tower construction is one of angle steel, but for tanks of over 50,000 gallons this construction is not economical and laced channel columns are used instead of the double angle columns. For the laced channel towers, the following formulas will apply for tank capacities ranging from 60,000 to 100,000 gallons:

50-foot towers,

$$\text{Weight of tower} = 26{,}000 - 4000\left(\frac{100{,}000 - C}{40{,}000}\right)$$

75-foot towers,

$$\text{Weight of tower} = 39{,}000 - 12{,}000\left(\frac{100{,}000 - C}{40{,}000}\right)$$

100-foot towers,

$$\text{Weight of tower} = 50{,}000 - 14{,}000\left(\frac{100{,}000 - C}{40{,}000}\right)$$

We have now provided a method of finding the approximate weight of any part of the structure and can, therefore, proceed with the calculations. We will give the weights of parts calculated by the foregoing formulas and also arrange computations in accordance with the outline previously given.

A. Dead Load in Post

Weight of water = 346,167 pounds.
Weight of roof = 4800 pounds.
Weight of tank = 19,200 pounds.
Weight of railing = 440 pounds.
Weight of balcony = 2000 pounds.
Weight of floor system = 8308 pounds.
Weight of tower = 20,500 pounds.
Total weight, 401,415 pounds.
Weight on each column = 100,354 pounds.

Multiplying 100,354 by 1.00692 we have 101,048 pounds for the dead load in one column. Multiplying 401,415 by 0.25173 we have 101,048, which is a good check on the other method and really simpler.

B. Tank Wind Overturning Moment

Assuming the tank roof as 2 feet larger than the tank and quarter pitch, we have a roof 22 feet in diameter and 5 feet 6 inches high. The vertical projected area is equal to $11 \times 5.5 = 60.5$ square feet. At 3 pounds per square foot, the wind on the roof becomes 182 pounds. The wind on the tank is $20 \times 20 \times 15 = 6000$ pounds. The cap-beams used for a 20 by 20 foot tank are 20-inch I-beams. This gives the wind on the floor system as $1.67 \times 20 \times 30 = 1002$ pounds. The total tank wind then is 7184 pounds. In case the floor system has not been designed and the size of the cap-beams is not known, the following formula will give the approximate bending moment in inch-pounds:

M = diameter $\times$ capacity $\times$ 2.

Then dividing by the fiber stress to be used, we have the section modulus of the cap-beam; 12,500 pounds per square inch is a safe value for fiber stress. Tests have shown that steel beams fail at from 30,000 to 35,000 pounds per square inch, and a fiber stress of 12,500 pounds gives a safety factor of from 2½ to 2¾. Some engineers use 16,000 pounds for the fiber stress, but that is too high, especially if the beams have a number of holes punched in the flanges, as this reduces the section in the most vital place. The tank wind leverage is 85 feet and $7184 \times 85 = 610{,}640$ foot-pounds = tank wind overturning moment.

C. Tower Wind Overturning Moment

The wind force per foot of tower for a 20 by 20 by 75 foot tank and tower is about 210 pounds. The posts are 73 feet long in order to give 75 feet elevation to the tank, and also to make it possible to use stock lengths of material.

$73 \times 210 = 15{,}330$ pounds = tower wind.

$15{,}330 \times 36.5 = 559{,}545$ foot-pounds = tower wind overturning moment.

D + E. Stress in Post due to Total Wind Load

In order to arrive at the diagonal column centers at the base of the tower we must first know the column centers at the top. The most economical center at the top is 0.59 times the inside diameter of the tank. For a 20-foot tank, according to this rule, it becomes 11 feet 6 inches. With a column batter 1 inch per foot of post length, the bottom centers become 23 feet 8 inches. The diagonal of 23 feet 8 inches is 33 feet 5⅝ inches = 33.46 feet. The total overturning moment is 1,170,485 foot-pounds. This divided by 33.46 gives a stress in the post, due to the wind, of 34,982 pounds.

F. Total Column Load

Total column load = $A + D + E$.

A = 101,048 pounds.
$D + E$ = 34,982 pounds

136,030 pounds, total column load.

G. Load in Anchor Rods

Weight of complete, loaded, structure 401,415 pounds.

$$D + E - \frac{\text{Weight of loaded structure} - \text{weight of water}}{4} =$$

$$34{,}982 - \frac{401{,}415 - 346{,}167}{4} = 34{,}982 - 13{,}812 = 21{,}170$$

pounds = load in anchor rods.

Strength of Columns

The necessary loads have now been determined to enable us to proceed with the sizes of tower members. The first thing to decide on is the size of the columns or posts. There have been unlimited discussions among engineers as to the proper formula for determining the strength of columns, but as yet nothing definite has been accomplished along that line. The lack of tests on large sized specimens has been the chief drawback. Consequently the designer must use the formula that he believes is best suited for the work upon which he is engaged. In the January, 1912, issue of MACHINERY, two tables were published giving safe strength per square inch of section for various lengths of columns, calculated according to two formulas in common use in tank tower design. The formula in most general use is:

$$\text{Strength per square inch} = 17{,}100 - 57\frac{L}{R} \text{ pounds.}$$

This formula is specified by the Inspection Department of the Associated Factory Mutual Fire Insurance Companies of Boston, Mass., for tank towers to be used in connection with sprinkler systems under its jurisdiction. The values given

by this formula are, however, rather high. The other formula referred to is:

$$\text{Strength per square inch} = 16{,}000 - 70\,\frac{L}{R} \text{ pounds.}$$

The values given by this formula are lower, but like all straight line formulas it is about right for medium heights, the results being too high at one end and too low at the other. In the preceding formulas, L is the distance between struts in inches, and R the least radius of gyration.

The *Engineering News*, of August 26, 1909, gives a record of government tests, made at the Watertown Arsenal, on columns of various shapes and lengths. The following gives the average stresses at which failure occurred: On 5-inch tubular columns the flat, round, pin and fixed end specimens show practically the same results. With a value of 50 for the factor $\frac{L}{R}$, failure occurred at 30,000 pounds fiber stress, while with a value of 150 for $\frac{L}{R}$ failure took place at 25,000 pounds. Here a straight line formula would do nicely as the intermediate lengths show failures almost in a line between the two extremes just mentioned. The rolled H-columns having values of 50 to 125 for $\frac{L}{R}$ failed at from 30,000 to 25,000 pounds with flat ends and at 30,000 to 22,000 pounds with pin ends. With 150 for the value of $\frac{L}{R}$ the flat ended columns failed at 20,000 and the pin ended columns at 15,000 pounds. Built-up angle and plate columns having flat and pin ends with values of 50 to 125 for $\frac{L}{R}$ failed at 33,000 to 30,000 pounds. With 175 for value of $\frac{L}{R}$, flat ended columns failed at 25,000 pounds and pin ended columns at 20,000 pounds.

All of the tests are not given, as we are not interested in anything under 50 or over 175 for the value of $\frac{L}{R}$. From the foregoing results the writer has developed the following formulas:

For tubular columns with flat or pin ends, having values of 50 to 150 for $\frac{L}{R}$, the ultimate strength per square inch is:

$$S = 30{,}000 - 50\left(\frac{L}{R} - 50\right) \text{ pounds.}$$

For rolled H-sections with flat ends and 50 to 125 for $\frac{L}{R}$:

$$S = 30{,}000 - 67\left(\frac{L}{R} - 50\right) \text{ pounds.}$$

For H-sections with pin ends and 50 to 125 for $\frac{L}{R}$:

$$S = 30{,}000 - 107\left(\frac{L}{R} - 50\right) \text{ pounds.}$$

For H-sections with flat ends and 125 to 150 for $\frac{L}{R}$:

$$S = 25{,}000 - 200\left(\frac{L}{R} - 125\right) \text{ pounds.}$$

For H-sections with pin ends and 125 to 150 for $\frac{L}{R}$:

$$S = 22{,}000 - 280\left(\frac{L}{R} - 125\right) \text{ pounds.}$$

For built-up sections with flat or pin ends and 50 to 125 for $\frac{L}{R}$:

$$S = 33{,}000 - 40\left(\frac{L}{R} - 50\right) \text{ pounds.}$$

For built-up sections with flat ends and 125 to 175 for $\frac{L}{R}$:

$$S = 30{,}000 - 100\left(\frac{L}{R} - 125\right) \text{ pounds.}$$

For built-up sections with pin ends and 125 to 175 for $\frac{L}{R}$:

$$S = 30{,}000 - 200\left(\frac{L}{R} - 125\right) \text{ pounds.}$$

In the work we are considering, tubular columns would not be adaptable as it would be hard to make good connections and splices with this section. They are occasionally used for light building work. The H-columns are rarely used for towers but are very well adapted for building work. The built-up angle column is used more than any other type except the single angle column which is the cheapest and best construction in the case of small tanks. The strength of single angle columns is limited, however, so that they cannot be used to advantage for tanks larger than 16 feet by 16 feet. In the January, 1912, issue of MACHINERY, on page 371, a type of column is shown that is used almost exclusively for tank towers, and from the sizes given in the Data Sheet Supplement for the same month, entitled "Properties of Double Angle Columns," we will select a column for the case in hand. We will also work out the value of the column by the three formulas just given, in order to show how they coincide, or rather how close they come to doing so.

We will first try a column made of two 6 by 6 by ½ inch angles fastened together by short tie plates, as shown in the article just referred to, and having a bottom panel length of 17 feet 6 inches = 210 inches. The radius of gyration of this section is 2.33 and the cross-sectional area 11.50 square inches.

$$\frac{L}{R} = \frac{210}{2.33} = 91$$

Using the formula: Strength per square inch = $17{,}100 - 57\,\frac{L}{R}$, a value of 91 for the slenderness factor $\frac{L}{R}$ gives the column a strength of 11,913 pounds per square inch or a total strength of 137,000 pounds.

Using the formula: Strength per square inch = $16{,}000 - 70\,\frac{L}{R}$, a value of 91 for $\frac{L}{R}$ gives a strength of 9630 pounds per square inch or a total column strength of 110,745 pounds. Both formulas are supposed to give a safety factor of 4, so it is interesting to note the comparative results.

Now we will try the formula derived from actual tests. With 50 to 125 for the value of $\frac{L}{R}$ we use the formula:

$$S = 33{,}000 - 40\left(\frac{L}{R} - 50\right)$$

and substituting a value of 91 for $\frac{L}{R}$ gives

$33{,}000 - 40\ (91 - 50) = 31{,}360$ pounds per square inch as the ultimate strength.

$31{,}360 \times 11.50 = 360{,}640$ pounds as the ultimate strength of the column. The load on the column is 136,030 pounds and $\frac{360{,}640}{136{,}030} = 2.65$ actual factor of safety according to the government tests.

Then for the formula: Strength per square inch = $17{,}100 - 57\,\frac{L}{R}$ pounds we have an actual factor of safety of $\frac{136{,}030}{137{,}000} \times 2.65 = 2.63$ instead of 4 as it is supposed to be.

In the formula: Strength per square inch = $16{,}000 - 70\,\frac{L}{R}$ pounds we have $\frac{136{,}030}{110{,}745} \times 2.65 = 3.25$ for the actual safety factor. Of course, these particular safety factors only apply at the point where the value of $\frac{L}{P}$ is 91. At either extreme of

the formulas, the difference will be greater.

We will try them with a value of 50 for $\frac{L}{R}$. For the first formula, the strength is 12,000 pounds per square inch, as that is the value specified for values of 90 and under for $\frac{L}{R}$. For the second formula, the strength is 12,500 pounds per square inch. According to the tests, failures for this length occurred at 33,000 pounds per square inch. Then the first formula gives a safety factor of $\frac{33,000}{12,000} = 2.75$. The second formula gives a factor of $\frac{33,000}{12,500} = 2.64$.

The first formula changes its safety factor between the points of 90 and 50 for the value of $\frac{L}{R}$ from 2.63 to 2.75. Owing to the fact that 12,000 pounds per square inch is called for with 90 and under as the value of $\frac{L}{R}$, there is a varying safety factor which becomes greater as the column grows shorter. If it worked the other way, so that the safety factor increased as the column grew longer, it would be preferable. The second formula changes at the same points from a factor of 3.25 to 2.64. With a value of 50 for $\frac{L}{R}$, the formula gives a safety factor of 2.64 instead of 4 as it is supposed to do.

We will now try the formulas with a value of 150 for $\frac{L}{R}$. The first formula gives 8550 pounds per square inch as the safe strength. The second formula gives 5500 pounds per square inch. The tests showed a value of the ultimate strength $S = 30,000 - 100\left(\frac{L}{R} - 125\right) = 27,500$ pounds per square inch. This gives the first formula a safety factor of $\frac{27,500}{8550} = 3.21$. The second formula has a factor of $\frac{27,500}{5500} = 5$. From this we can see that the two formulas do not have a uniform safety factor throughout their length, although they are both supposed to have a factor of 4. The first one varies between the 100 points considered in two ways. From 91 to 150 as the value of $\frac{L}{R}$, the safety factor changes from 2.63 to 3.21, and for values of $\frac{L}{R}$ from 90 down to 50, the safety factor changes from 2.63 to 2.75. At that rate, the formula shows the column to be weakest for the middle points. The second formula has a gradual increase in its safety factor ranging from 2.64 with a value of 50 for $\frac{L}{R}$ to 5 with 150 for $\frac{L}{R}$.

We ought not to have an actual factor of safety of less than 3 and as two 6 by 6 by ½ inch angles do not meet this requirement we will try two 6 by 6 by 9/16 inch angles, which have a radius of gyration of 2.32 and a section area of 12.86. $\frac{L}{R} = \frac{210}{2.32} = 91$. With this length of column, the section is good for 31,360 pounds per square inch ultimate strength, as previously determined according to the writer's formula. This gives a total column strength of 403,290 pounds. We then have a safety factor of $\frac{403,290}{136,030} = 2.98$.

When we know that we have an actual safety factor of practically 3 under the maximum conditions of loading, we need feel no apprehension as to the design of our structure, providing, of course, that all joints and splices are made of the same strength as the main members. When we merely use formulas that give a varying safety factor we cannot feel sure that we have obtained safe results. As previously mentioned, the total length of posts for this tower will be 73 feet, and the structure will be divided into four panels. Starting with the bottom panel and going up, the panel lengths will be 17 feet 6 inches, 18 feet, 18 feet 6 inches, and 19 feet. The bottom panel should always be shorter where the same size post is used throughout, as the heaviest load occurs at the bottom, the loads becoming lighter toward the top so that the panels can be gradually lengthened. Of course, where a lighter post is introduced, this may not be possible. It will be necessary to calculate the loads in all panels when great economy in the use of material is practiced.

It appears that in the case under consideration we can reduce the post in the third panel from the bottom to two 6 by 6 by ½ inch angles. The tank wind leverage is decreased by 35 feet 6 inches and becomes 49 feet 6 inches. This gives: 7184 × 49.5 = 355,658 foot-pounds = tank wind overturning moment in upper panels. The height of the tower is likewise decreased by 35 feet 6 inches and becomes 37 feet 6 inches.

37.5 × 210 = 7875 pounds = tower wind in upper panels.
7875 × 18.75 = 147,656 foot-pounds = tower wind overturning moment in third panel.

The total overturning moment in the third panel is then 503,314 foot-pounds. The diagonal column centers at the bottom of the panel considered are 25.10 feet.

$$\frac{503,314}{25.10} = 20,052 \text{ pounds} = \text{column wind load.}$$

The dead and water load will be the same as before, with the exception of the tower weight which will be reduced nearly half. We can obtain the approximate weight by direct proportion, thus:

$\frac{37.5}{73} \times 20,000 = 10,274$ pounds = weight of lower panels.
20,000 — 10,274 = 9726, and 9726 ÷ 4 = 2431 pounds = reduction in tower weight on each post.
101,048 = dead load for bottom panel,
2431 = reduction in tower weight,
98,617 = new dead load per post.

Then 98,617 + 20,052 = 118,669 pounds = column load in panel under consideration.

The panel length L is 18 feet 6 inches or 222 inches and the least radius of gyration $R = 2.33$.

$$\frac{L}{R} = \frac{222}{2.33} = 96.$$

According to Formula (3) this gives a unit strength of 31,160 pounds per square inch or a column strength of 358,340 pounds ultimate.

$$\frac{358,340}{117,850} = 3.04 \text{ safety factor.}$$

This shows that it is safe to use two 6 by 6 by ½ inch angles in the two top panels.

* * *

The desire to rate everything mechanical by horsepower has led to some peculiar expressions. We have 1000 H. P. boilers, 1000 H. P. feed water heaters, 1000 H. P. condensers, 1000 H. P. exhaust heads, etc. Rolling mill reversing engines frequently are rated by horsepower. We hear about 10,000 H. P. engines, 20,000 H. P. engines, and even 30,000 H. P. engines. The well-known engine size which for years was standard in American mills, namely 55 inches by 60 inches, when run with full steam admission, will develop over 25,000 H. P. at a speed of 250 R. P. M. And yet any such rating is arbitrary and misleading. The engine works with full steam admission only at low and medium speeds. When running at high speed, it works with greatly reduced steam admission, so that the horsepower developed by the 25,000 H. P. engine never exceeds 6000. In a test made on a blooming mill of the Pittsburg district the horsepower in the early passes was about 4000; it rose to less than 5500, and in the last pass it dropped again below 4000 in spite of the greatly increased speed. It is obvious that the steam engine cannot develop more power than the mill will take. On account of the fact that the engine cannot develop more power than the mill will take it is probably best to rate the rolling mill reversing engines solely by their cylinder sizes.

AUTOMATIC SCREW MACHINE EQUIPMENT*—1

TOOL EQUIPMENT USED ON NATIONAL-ACME MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINES

BY DOUGLAS T. HAMILTON†

The standard tool equipment used on the "Acme" multiple-spindle automatic screw machine is somewhat similar in design to that used on any other screw machine, but, of course, a number of the tools are especially designed for this type of automatic screw machine. The standard tools used comprise spring chucks, feed chucks, circular form and cut-off tools, straight and blade type forming and cutting-off tools, drill-, tap- and die-holders, box-tools, etc. Under the heading of special tools are included shaving tools, thread rolling tools, reaming attachments, etc. In the following article these various tools will be illustrated and described.

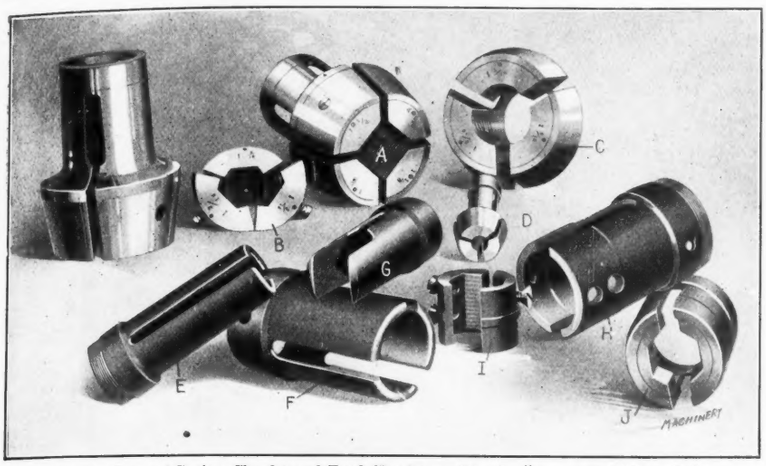


Fig. 1. Type of Spring Chucks and Feed Chucks used in the "Acme" Multiple-spindle Automatic Screw Machine

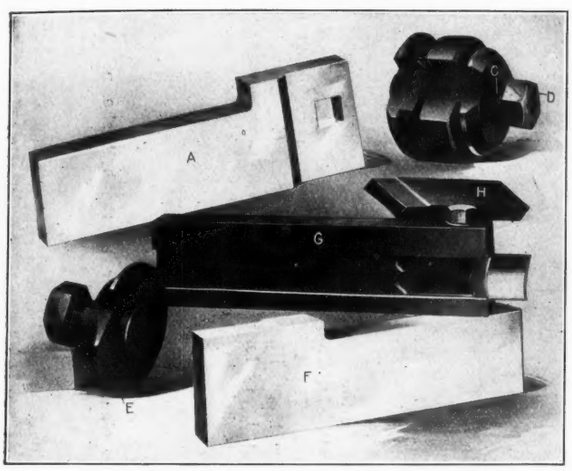


Fig. 2. Circular Form and Cut-off Tools and Holders, and Blade Type of Cut-off Tools and Holders

Spring Chucks and Feed Chucks

The spring chucks for holding the bars when they are being operated upon are of the push-in type, a group of which appears in Fig. 1. In the larger machines—sizes 52, 53, 54, 55 and 56 these spring chucks are provided with jaws *B*, which are held in place in the chuck by screws. The spring chuck at *A* is provided with jaws for holding square stock, whereas that at *C* is for holding round bars. *D* shows the type of "solid" chucks which are used in the smaller machines. When conditions will permit the front of the chucks to be counterbored so as to hold jaws, they are then known as master chucks. This greatly increases their capacity, as it is evident that the same chucks can be used for holding various diameters of stock simply by substituting jaws of the proper size.

The dimensions of the solid and master spring chucks used in the various sizes of machines are given in Table I. Here it will be noticed in numerous instances throughout the table that no dimensions are given; the reason for this is that the shape of the chuck is changed from that shown in the illustration. For instance, in Column F size 52 has no flat, the tapered nose in these chucks extending up to the shoulder. In Column J, sizes 51 and 515 are not provided with jaws, so in this case the chucks would not be counterbored in the front end, but are bored straight to suit the bars which they are made to hold. The same remarks apply to Column N, except that for sizes 54 and 56. the holes in the chucks are made straight, but are meant to hold jaws. The counterbored seat *P* is omitted, of course, in the solid type of spring chucks; also pin holes *Q* and dimensions *U*. The same remarks made in connection with Column N apply to T. The depth of the counterbore in the master spring chucks for the screws holding the jaws should not extend beyond the line *X* in the engraving. Chucks intended to hold square stock should have four slots, at ninety degrees. A 5/16-inch

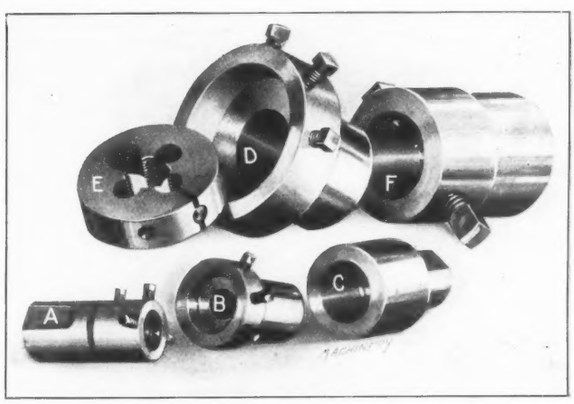


Fig. 3. Tap and Die Holders and Extension Shanks

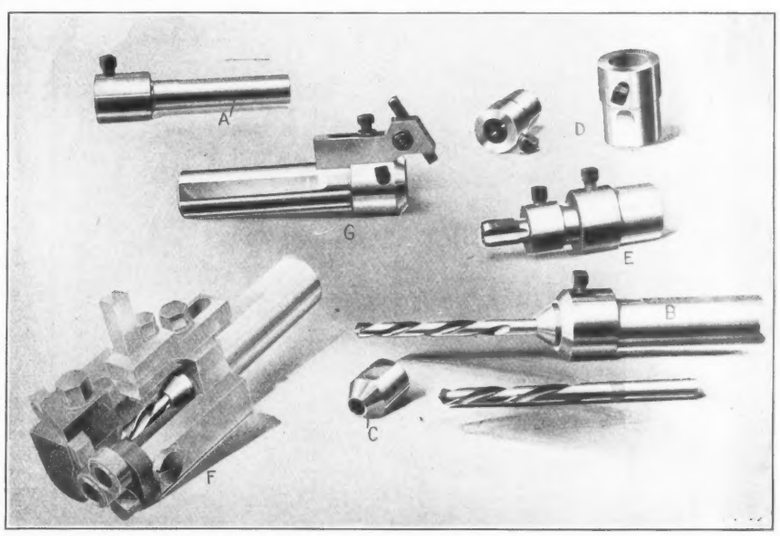
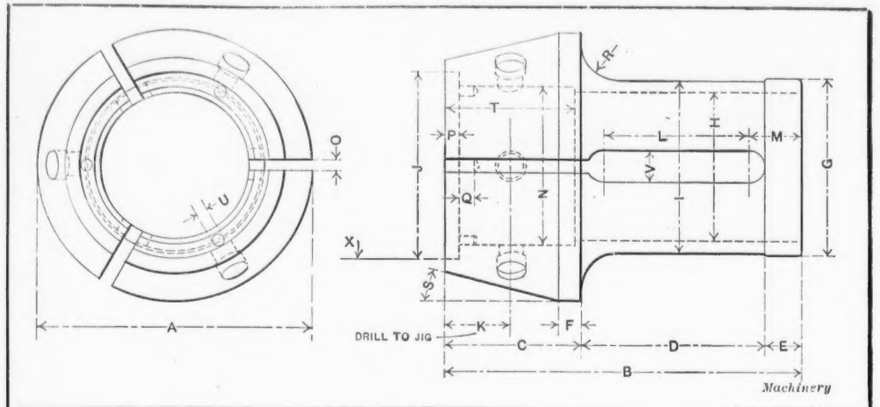


Fig. 4. Standard Drill Holders and Bushings

* For further information on National-Acme screw machine equipment, see "The Acme Multiple Spindle Automatic Screw Machine," December, 1912, and January, 1913.

† Associate Editor of MACHINERY.

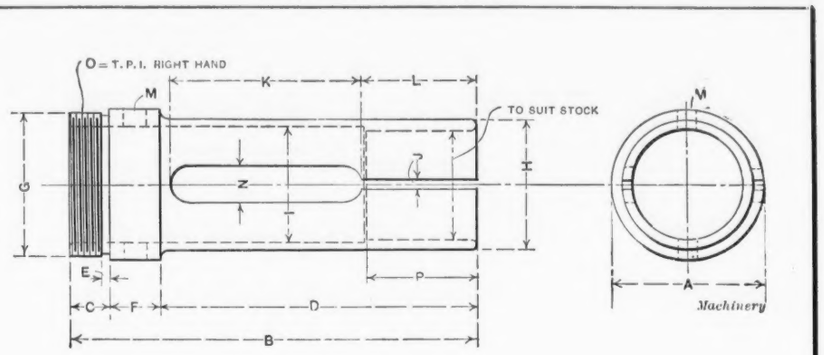
TABLE I. PRINCIPAL DIMENSIONS OF SPRING CHUCKS USED IN "ACME" MULTIPLE SPINDLE AUTOMATIC SCREW MACHINES



Machine, No. or Size	Dimensions in inches																				
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
51	$\frac{7}{8}$	$1\frac{25}{32}$	$\frac{19}{32}$	$\frac{31}{32}$	$\frac{7}{32}$	$\frac{1}{16}$	$\frac{41}{64}$	$\frac{7}{16}$	$\frac{19}{32}$	...	...	$\frac{11}{16}$	$\frac{5}{16}$	...	$\frac{5}{64}$	..	..	$\frac{1}{8}$	$16\frac{1}{2}$	...	..	$\frac{3}{16}$
515	$1\frac{9}{16}$	$2\frac{13}{32}$	$\frac{3}{4}$	$1\frac{1}{16}$	$\frac{9}{32}$	$\frac{1}{32}$	$1\frac{1}{16}$	$\frac{15}{16}$	1	...	...	$1\frac{25}{32}$	$\frac{1}{2}$	...	0.081	..	..	$\frac{1}{4}$	13°	...	..	$\frac{1}{4}$
52	$1\frac{7}{8}$	3	$1\frac{1}{16}$	$1\frac{7}{8}$	$\frac{7}{16}$	..	$1\frac{1}{4}$	$1\frac{15}{16}$	$1\frac{3}{16}$	$1\frac{5}{16}$	$\frac{25}{64}$	$1\frac{1}{2}$	$\frac{9}{16}$	$1\frac{1}{16}$	$\frac{7}{64}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{4}$	13°	$\frac{33}{32}$	#42	$\frac{1}{4}$
53	$2\frac{1}{4}$	$3\frac{9}{16}$	$1\frac{1}{8}$	$1\frac{15}{16}$	$\frac{1}{2}$	$\frac{3}{32}$	$1\frac{33}{64}$	$1\frac{7}{32}$	$1\frac{29}{64}$	...	$\frac{9}{16}$	$1\frac{7}{8}$	$\frac{19}{32}$	$1\frac{1}{8}$	$\frac{7}{64}$	..	..	$\frac{1}{4}$	13°	1	..	$\frac{5}{16}$
54	$2\frac{11}{16}$	$3\frac{7}{16}$	$1\frac{1}{8}$	$1\frac{13}{16}$	$\frac{7}{16}$	$\frac{1}{4}$	$2\frac{1}{64}$	$1\frac{7}{32}$	$1\frac{15}{16}$	2	$\frac{23}{32}$	$1\frac{7}{8}$	$\frac{23}{32}$	...	$\frac{7}{64}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{4}$	13°	...	$\frac{1}{8}$	$\frac{25}{64}$
55	$3\frac{9}{16}$	$4\frac{3}{4}$	$1\frac{13}{16}$	$2\frac{5}{16}$	$\frac{5}{8}$	$\frac{5}{16}$	$2\frac{21}{64}$	2	$2\frac{5}{16}$	$2\frac{1}{2}$	$\frac{61}{64}$	$1\frac{7}{8}$	$\frac{25}{32}$	$2\frac{1}{8}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{2}$	13°	$1\frac{1}{8}$	$\frac{1}{8}$	$\frac{7}{16}$
56	$4\frac{1}{16}$	$5\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{16}$	$3\frac{1}{16}$	2	3	3	$\frac{61}{64}$	$1\frac{7}{8}$	$\frac{13}{16}$	...	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{2}$	$12\frac{1}{2}$	...	$\frac{1}{8}$	$\frac{1}{2}$

Machinery

TABLE II. PRINCIPAL DIMENSIONS OF FEED CHUCKS USED IN THE "ACME" MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE



Machine, No. or Size	Chuck Capacity in Ins.			Dimensions in Inches															
	Round	Square	Hex.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
51	$\frac{1}{4}$	0.176	0.216	0.465	$1\frac{7}{8}$	$\frac{3}{8}$	$1\frac{1}{8}$	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{13}{32}$	$\frac{9}{32}$	$\frac{5}{64}$	$\frac{3}{32}$	$\frac{1}{2}$	$\frac{3}{16}$	$\frac{1}{8}$	32	$\frac{1}{2}$
515	$\frac{9}{16}$	0.398	0.487	$\frac{27}{32}$	$3\frac{1}{16}$	$\frac{7}{16}$	$2\frac{1}{4}$	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{13}{32}$	$\frac{9}{32}$	$\frac{5}{64}$	1	$\frac{3}{16}$	$\frac{3}{16}$	30	$\frac{13}{16}$
52	$\frac{3}{4}$	0.530	0.649	$\frac{31}{32}$	$3\frac{7}{16}$	$\frac{7}{16}$	$2\frac{1}{2}$	$\frac{3}{32}$	$\frac{1}{2}$	$\frac{7}{8}$	$\frac{29}{32}$	$\frac{5}{16}$	$\frac{5}{64}$	1	$\frac{3}{16}$	$\frac{3}{16}$	30	$\frac{7}{8}$	
53	1	0.707	0.866	$1\frac{1}{32}$	$4\frac{5}{16}$	$\frac{7}{16}$	$3\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{2}$	$1\frac{1}{16}$	$1\frac{1}{16}$	1	$\frac{5}{64}$	$2\frac{1}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	24	$\frac{15}{16}$	
54	$1\frac{1}{32}$	0.972	1.190	$1\frac{29}{32}$	$4\frac{9}{16}$	$\frac{7}{16}$	$3\frac{1}{16}$	$\frac{3}{32}$	$\frac{9}{16}$	$1\frac{1}{16}$	$1\frac{1}{2}$	$1\frac{5}{16}$	..	..	..	$\frac{5}{16}$	24	$1\frac{1}{4}$	
55	$1\frac{1}{8}$	1.24	1.51	2	$4\frac{5}{8}$	$\frac{7}{16}$	$3\frac{1}{2}$	$\frac{1}{16}$	$\frac{11}{16}$	$1\frac{7}{8}$	$1\frac{13}{16}$	$1\frac{11}{16}$	..	..	..	$\frac{5}{16}$	$\frac{7}{16}$	24	$1\frac{1}{4}$	
56	$2\frac{1}{4}$	1.766	2.19	$2\frac{29}{64}$	$4\frac{3}{4}$	$\frac{1}{2}$	$3\frac{1}{2}$	$\frac{1}{16}$	$\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{3}{8}$	$2\frac{3}{16}$	..	..	..	$\frac{3}{8}$	$\frac{1}{2}$	24	$1\frac{1}{2}$

Machinery

drill and a 3/8-inch counterbore are used for all screws, except in the 56 size where a 3/8-inch drill and a 1/2-inch counterbore are used.

A group of feed chucks, illustrating the types used in the "Acme" multiple-spindle automatic screw machine for feeding various shapes of stock, also appear in Fig. 1. *E* shows the regular feed chuck, *F*, the type used in the 56 machine for feeding heavy stock, and *G* the feed chuck for handling square stock. *H* shows a master feed chuck with the jaws removed, while *I* shows the jaws used. *J* is the same feed chuck showing the jaws in place. The dimensions and capacities of the feed chucks used in the various sizes of machines are given in Table II, to which the following remarks apply. Referring to Columns J, K and L, it will be seen that the dimensions for the 54, 55 and 56 sizes are not given; the reason for this is that slot *J* is continued up nearly to the shoulder, and is of the same width for its entire length. When jaws are used, the chuck is bored out larger than the diameter of the stock.

Forming and Cutting-off Tools

The forming and cutting-off tools, which are generally held on the side-working tool slides, and are sometimes held on the top-working tool slides when necessary for light forming, are shown in Fig. 2. Here *A* is the holder for the circular forming tool *B*, which is held on a stud *C*, the latter fitting in a square hole in the holder. The nut *D*, when tightened, draws the headed stud in, clamping the tool tightly against the face of the holder. The side of the tool which goes next to the holder is provided with concentric grooves to prevent it from turning when heavy forming is to be done. A circular cut-off tool which is held in the same manner is shown at *E*. *F* shows a blank holder for carrying circular forming or cutting-off tools.

The holder used for retaining the blade type of cut-off tool is shown at *G* with a cut-off blade in position. This holder is split and is clamped together by the bolt shown. A wider cut-off blade is shown at *H*. Table III gives the various dimensions of the blade type of cut-off tool-holders shown in connection with this table and also at *G* in Fig. 2, for the different sizes of machines. This holder is made from cold-rolled steel and is left soft. Upon referring to Table III, it will be noticed that the width of the tool *B* is in all cases expressed in decimals. The reason for this is that the tool-holders, in order to be easily inserted, are made from 0.005 to 0.010 inch less in width than the slots in the slides, which are made to even fractions.

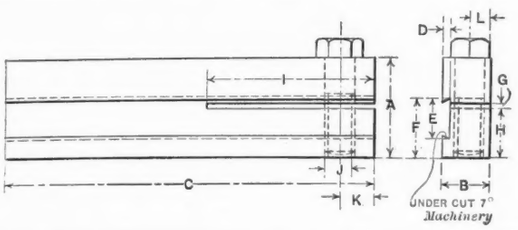
The principal dimensions of the circular form and cut-off tools, and also the holder and stud used for retaining them are given in Table IV, the notation used appearing in the illustration accompanying the table. In this illustration is also shown the gage used in setting the cutting edge of the tool in the proper relation to the bottom of the holder, which always bears the same relation to the center of the work. To provide for sufficient periphery clearance, the cutting edge of the circular form and cut-off tools is located a distance *B* below the center of the tool. For cutting brass, the top face of the cutting portion of the tool is usually parallel with the center line drawn through the axis of the tool, but in some cases, especially on soft brass, a negative rake is given as shown by the angle *a*. The cutting angles for the various materials specified are as follows:

Material	Cutting Angle in Degrees
Soft brass	$\alpha = 5$
Drill rod and tool steel	$\beta = 8 - 10$
Gun screw iron	$\beta = 12$
Machine steel	$\beta = 15$
Norway iron	$\beta = 18$
Copper and aluminum	$\beta = 25 - 30$
German tubing	$\beta = 25 - 35$

In regard to the location of the cutting edge of the tool in relation to the center of the work, the following points should be observed: For cutting steel and iron, the cutting edge of the tool should be set directly on the center of the work, while for cutting brass, bronze, copper and aluminum, better results are sometimes obtained by setting the cutting edge of the tool slightly above the center. This does not apply to some classes of bronze, especially that grade known as "Tobin" bronze. For this material, the cutting edge should be set the same as for steel.

Locating the cutting edge of the tool below the center, as shown in the illustration accompanying Table IV, changes the relative differences between the diameters of the tool (where it is used for forming more than one diameter), so that it is necessary to calculate the dimensions required on the forming tool. The formulas to use and the method to follow in making the required calculations will be found in MACHINERY'S Reference Book No. 101 on "Automatic Screw Machine Practice." Additional information on the subject of circular form and cut-off tools will also be found in the book just referred to.

TABLE III. PROPORTIONS FOR HOLDERS USED IN RETAINING BLADE TYPE OF CUT-OFF TOOLS



Machine Numbers	Dimensions in Inches											
	A	B	C	D	E	F	G	H	I	J	K	L
51	1 1/4	0.588	4 4/4	7/64	1/8	8/64	1/16	5/64	2 1/2	28-16.P.	7/16	1/4
515	1 1/4	0.588	4 4/4	7/64	1/8	8/64	1/16	5/64	2 1/2	28-16.P.	7/16	1/4
52	1 1/4	0.588	4 4/4	7/64	1/8	8/64	1/16	5/64	2 1/2	28-16.P.	7/16	1/4
53	1 11/16	0.838	7	17/64	53/64	1 1/8	3/32	15/64	2 1/2	28-16.P.	9/16	5/16
54	1 11/16	0.838	7	17/64	53/64	1 1/8	3/32	15/64	2 1/2	28-16.P.	9/16	5/16
55	1 11/16	0.838	7	17/64	53/64	1 1/8	3/32	15/64	2 1/2	28-16.P.	9/16	5/16
56	2 1/8	1.083	8	13/32	31/32	1 9/16	1/8	1 5/16	2 3/4	1/2-13.P.	5/8	3/8

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Drill-, Tap- and Die-holders

The drill-holders used in the "Acme" multiple-spindle automatic screw machine are of the ordinary type, as shown at *A* and *B* in Fig. 4, and are supplied with split bushings *C* which are turned cone-shaped on the end to assist in removing the chips from the flutes of the drill. With this type of bushing, of course, it is necessary to make a bushing for each size of drill. The shank of the holder is usually made to a standard length and adjusted by the screws in the tool spindle in which it is used. The type of drill-holder used in the threading spindle is shown in Fig. 5, and also at *D* in Fig. 4. The holder *A*, see Fig. 5, is retained in the threading spindle and carries the additional holder *B* in which the drill is held in a bushing by the set-screw shown. These drill-holders are also used for holding taps in the threading spindle as shown at *E* in Fig. 4. An over-cut box-tool holding a drill is shown at *F*.

In Fig. 3, *A* is a friction die-holder which is used when threading up to a shoulder on small work, when a button die is used for this purpose. *B* is a die-holder of small size, and *C* is an extension holder in blank form. *D* shows a larger

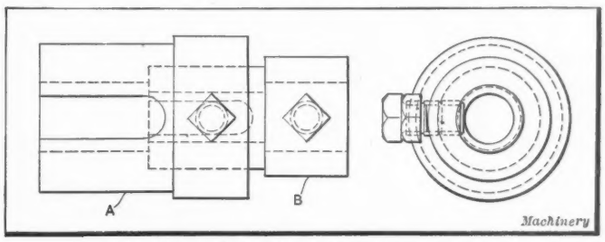


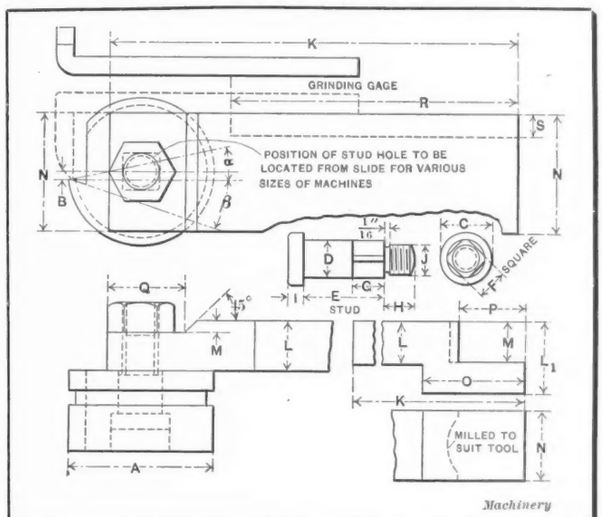
Fig. 5. Type of Drill-holder held in Threading Spindle

die-holder and *E* the type of button die used in it, while *F* shows the extension shank retained in the threading spindle.

Telescopic Die- or Tap-holder

A telescopic or combination die- or tap-holder is shown in Fig. 6, which, as can be seen, enables two threading operations to be completed at the same time; that is, two dies of different diameters can be used, or a die and tap as required, the tap, of course, being held in the rear part of the holder. This special tool consists of a shank *A* in which a button die *B* is held by the cone-pointed screw shown. When a tap is to be used, the button die is replaced by a bushing for holding it. The front part *C* of the holder which carries the leading button die, is a sliding fit on a key in member *A*.

TABLE IV. PRINCIPAL DIMENSIONS OF CIRCULAR FORM AND CUT-OFF TOOLS, HOLDERS AND STUDS FOR RETAINING THEM



Dimensions in Inches	Machine Numbers						
	51	515	52	53	54	55	56
A	1 1/2	1 1/2	2	2 2/4	2 1/4	2 1/2	3
B	3/32	3/32	3/32	1/8	5/32	5/32	3/16
C	25/64	25/64	25/64	33/64	33/64	33/64	33/64
D	0.622	0.622	0.747	0.747	0.747	0.747	0.747
E	1 13/32, 1 1/32, 25/32	1 13/32, 1 1/32, 25/32	1 13/32, 1 1/32, 25/32	2 3/32, 1 11/32, 27/32	2 3/32, 1 11/32, 27/32	2 3/32, 1 11/32, 27/32	2 7/32, 1 15/32, 31/32
F	1/2	1/2	1/2	5/8	5/8	5/8	5/8
G	9/16	9/16	9/16	5/8	5/8	5/8	5/8
H	1/2	1/2	1/2	11/16	11/16	11/16	11/16
I	1/4	1/4	1/4	5/16	5/16	5/16	5/16
J	1/2-16.P.	1/2-16.P.	1/2-16.P.	5/8-16.P.	5/8-16.P.	5/8-16 P.	5/8-16.P.
K	5 1/4	5 1/4	5 1/4	7	7	7	8
L	23/32	23/32	23/32	27/32	27/32	27/32	1 3/32
L_1	1 1/4	1 1/4	1 1/4	...	...	...	...
M	11/16	11/16	11/16	7/32	7/32	7/32	11/32
N	1 3/16	1 3/16	1 3/16	2	2	2	2 7/16
O	1 3/4	1 3/4	1 3/4	...	...	...	...
P	1 1/8	1 1/8	1 1/8	...	...	...	...
Q	...	...	...	1 1/2	1 1/2	1 1/2	1 9/16
R	...	...	...	4 1/8	4 1/8	4 1/8	4 1/8
S	...	...	...	5 1/2	5 1/2	5 1/2	5 9/16

Machinery

Offset type of holder shown to right in illustration is used only on 51, 515 and 52 machines.

To enable the cutting of two threads of different pitches at the same time, the front member *C* is restrained by two coil springs *D*, which allow it to lead out in advance of the other part of the holder, and as the shank *A* is held in the die spindle, which also is spring-controlled as regards the leading out of the spindle, it is evident that the lead of the two members is controlled by the pitch of the thread in the dies. A stop-screw *E* is provided for locating the holder *C* in its backward position, so that the two dies will always be in the same relation to each other when starting to cut. Clearance cuts are provided in both members to facilitate the removal of chips.

Opening Die-holder and Operating Attachment

Figs. 7, 8 and 9 show an opening die-holder which is recommended for cutting long threads of accurate pitch; this is designed especially for use on the "Acme" multiple-spindle automatic screw machine where it is necessary for the die to rotate. The working mechanism is enclosed within the body *A*, see Fig. 8, which carries the cam operating blocks. The head *B* holds the chasers *C*, which have closing and adjusting cams milled on their outer ends that bear against the cam operating blocks *D*.

The chasers *C* are held in place by screws *E*, and they can be removed without displacing any of the other parts. The adjustment of the chasers is controlled by a fine-pitch screw, the amount of adjustment being indicated by the micrometer graduations *F*, Fig. 7. The chasers and the cam surfaces controlling the closing of the die are hardened and ground, and the wide bearings on the cam surfaces hold the chasers firmly in position when the die is closed.

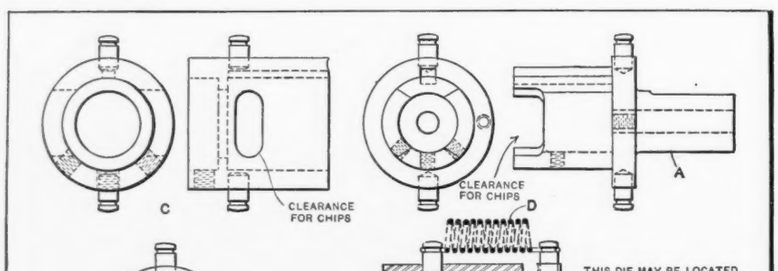


Fig. 6. Telescopic or Combination Die- and Tap-holder

Two positions of the die are illustrated in Fig. 9, the view to the right showing it closed, and the one to the left open. This opening die is operated by a shoe *I*, Figs. 10 and 11, engaging in the groove *S*, Fig. 7, which shifts the shell *A* and tapering cam *D* with relation to the chasers, thus causing the latter to move inward or outward, as the case may be. The chasers are so designed that they cut a practically perfect thread without the aid of a follow-up cam. No springs are

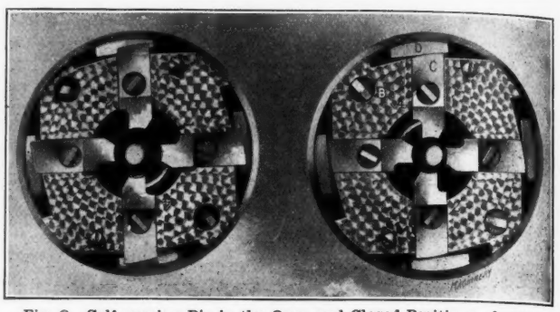


Fig. 9. Self-opening Die in the Open and Closed Positions, showing Operating Mechanism

connected to the parts on which the adjustment of the dies or the operation of the closing cams depends. Chips are prevented from entering the head by cap *G*, see Fig. 8, and the die may be thoroughly cleaned simply by removing the screws *H* and cap *G* and washing it in kerosene. One wrench is all that is necessary for taking the die apart.

The mechanism for operating the self-opening die illustrated in Figs. 7, 8 and 9, is shown attached to the machine, and in two working positions, in Figs. 10 and 11. Fig. 10 shows the attachment in the position it occupies when the die is closed and ready to start on the work, whereas Fig. 11 shows the operating mechanism about to act and open the die at the completion of the thread. This self-opening die is held in and rotated by the threading spindle in the usual manner, and is connected to the operating attachment by a shoe *I*, which fits in the groove *S*, Fig. 7, as mentioned. Another shoe *J*, similar in shape to shoe *I*, is connected to the rear end of the threading spindle, and is held on a spindle *K* (being adjusted by check-nuts), which is retained in the bracket *L* attached to the end-working tool slide.

In operation, as the end-working tool slide advances, the chasers in the die come in contact with the work and start to "lead" on. When the pitch of the thread is greater than the forward advance of the tool slide, the spring *M* is compressed by the threading spindle being withdrawn; this action, of course, carries forward the two shoes *I* and *J* at the same speed. When the die chasers have advanced on the work to the required distance, the sleeve *N* comes in contact with adjustable stop *O* held in bracket *P*. This bracket is provided with the adjusting screw shown, and is attached to the casing

Fig. 7. Self-opening Die for Use in the "Acme" Automatic

Fig. 8. Self-opening Die dismantled

enclosing the cylinder. When the die starts to cut, the shoe *I* stops and holds the sleeve *N*, while the head and chasers, following the lead of the thread, advance until they come out of contact with the cam-operating blocks, allowing the head to spring open. Then as the end-working tool slide drops back, the lever *Q* striking the rear dog *R* acts on the rear check-nut

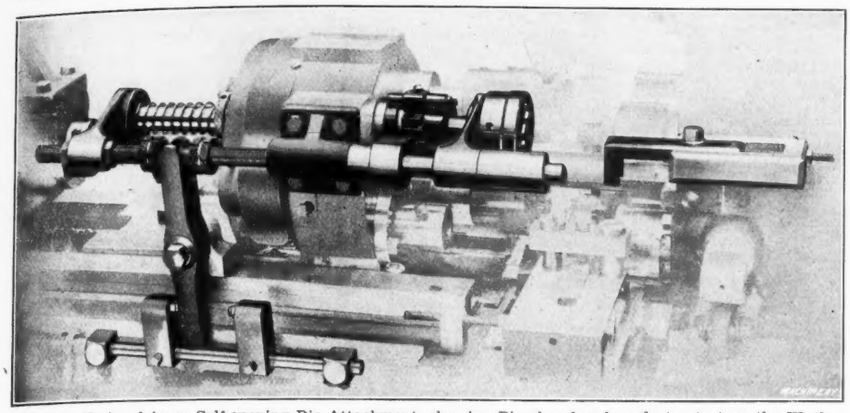


Fig. 10. National-Acme Self-opening Die Attachment, showing Die closed and ready to start on the Work

T, while the shoe *I* holds the casing from moving back, pulling the head back into the casing and closing the die, ready for cutting the next thread.

Drills, Reamers and Threading Dies

For general drilling in the "Acme" automatic, the ordinary commercial left-hand twist drills are used with good results, although there are times when a straight fluted, half round or gun drill would give better results, especially for deep-hole drilling. The greatest difficulties met with in drilling deep holes are those due to the clogging of chips and to the point of the drill heating and binding in the hole. To avoid these difficulties, the lip of the drill should be ground so that the chips will be coiled close, or in other words, so that a compact chip will be produced. For deep-hole drilling in brass, a straight fluted drill is preferable to a twisted one. The clogging of chips, however, is seldom encountered in the "Acme" automatic in drilling deep holes, owing to the method of tooling, which on many pieces provides for the use of two or more drills. When drilling deep holes, it is general practice to cut the lead cam

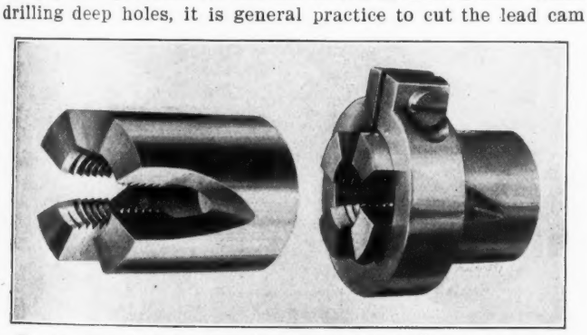


Fig. 12. Type of Spring Threading Dies used in the "Acme" Automatic

into sections, and put on extra backing-off cams, so that the drills are drawn out of the hole and flooded with oil, cooling them off and removing the chips.

Reamers of the "rose" type are generally used in screw machines for producing straight holes, and are made to cut only on the ends which are beveled to an angle of 45 degrees. The body is slightly tapered back from the end to provide for clearance, and is furnished with grooves having the edges rounded, to carry away the chips and conduct the oil into the hole. For brass, the cutting edges of the reamer are made parallel with the axis, but for machine steel the reamer gives better results when the flutes are cut helically. A spiral of about one turn in twelve inches is used to advantage. For reaming tapered holes, a reamer having serrated flutes gives the best results, and when the taper is steep—having an included angle greater than thirty degrees—the finishing reamer should be preceded by a stepped counterbore.

The two principal types of dies used are shown in Figs. 3 and 12. In Fig. 3, *E* is a round split button die, whereas in Fig. 12, two views of a spring or mill die are shown. The die to the right is shown with an adjusting collar on it. The button type of die is cheaper to manufacture, but when dull is difficult to sharpen (especially the smaller sizes) and must be discarded. The spring die, on the other hand, is more expensive to make, but has the advantage of being more easily sharpened. The cutting edges are ground by means of a knife-edge wheel inserted between the prongs. [For additional information on this subject, see MACHINERY'S Reference Book No. 103, "Automatic Screw Machine Practice."—EDITOR.]

Accelerated Reaming Attachment

For reaming holes which exceed in depth the travel of the end-working tool slide, an accelerated reaming attachment (shown in Fig. 13 and in detail in Fig. 14) is used. This at-

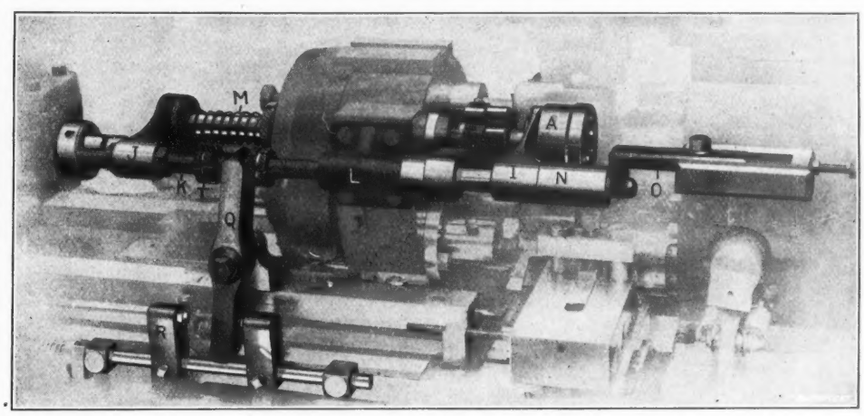


Fig. 11. The Self-opening Die Attachment in the Tripping Position

tachment is held in the "fourth" end position in the tool slide, and consists of the regular cast-iron collet *A* which fits in the hole in the tool slide. It is also furnished with a flange which provides a means of fastening it to the face of the tool slide by screws, and it is, for this attachment, steel bushed. The reamer holder *C* is a sliding fit in the steel bushing *B*, and is furnished with a loose cap *D* in which the reamer is held by the set-screw shown. The cap *D* is held to the holder

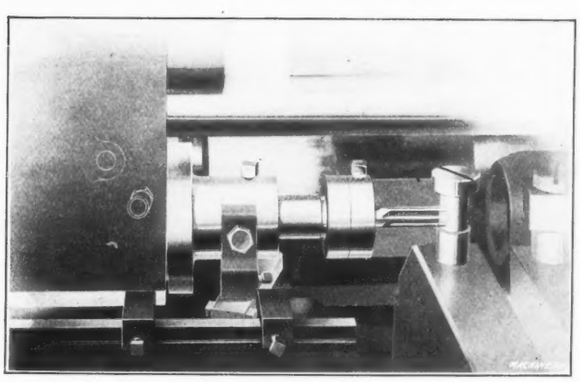


Fig. 13. View showing the Accelerated Reaming Attachment in its "Out" Position

C by two shoulder-head screws, the bodies of which are 1/32 inch smaller in diameter than the holes in the cap, thus allowing the cap to "float" a slight amount.

A stud *E* screwed into the shank of the holder *C* and working in an elongated slot in the bushing and collet, projects through from the under side of the collet and works in an elongated slot in the lever *F*. This lever is fulcrumed on a screw which is located in either holes *G* or *H*, depending on the excess amount of travel required, and is the medium used for accelerating the travel of the reamer. To increase the travel, the screw is placed in hole *H*, and to reduce the travel, the lever is moved back so that the screw would take the *H* position. In the illustration, the lever is shown in the intermediate position.

The bracket *I* in which the lever is fulcrumed is fastened to collet *A* and, of course, advances with the end-working tool slide. The rear end of lever *F* is provided with two hardened

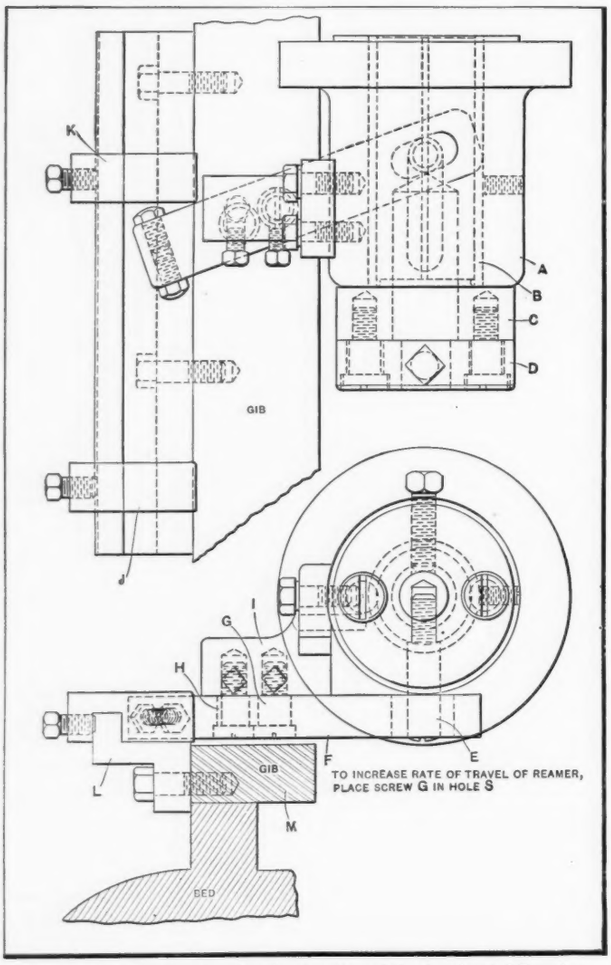


Fig. 14. Illustration showing Construction of the Accelerated Reaming Attachment shown in Fig. 12

screws rounded on the heads, which come in contact with the dogs *J* and *K* when the device is in operation. These dogs are adjustable on the bracket *L*, fastened to the gib *M*, which, in turn, is held to the bed of the machine.

In operation, as the end-working tool slide advances, the round-headed screw in the front face of the lever comes in contact with dog *J*, and as the tool slide continues to advance, this dog acts upon the fulcrumed lever, drawing out the reamer holder and accelerating its movement. The position of dog *J* on the bracket, and also the location of the screw in holes *G* or *H*, determines the amount of excess movement given to the reamer. When the tool slide drops back, dog *K* returns the reamer holder by means of lever *F* to its "back" position.

* * *

The word "patent" as referring to an industrial monopoly, granted by the State, was used the first time in England in 1331. This first patent was granted by a so-called "letter of protection," or, as it was termed in the learned language of that time—Latin—"litterae patentes" (open letter). From the latter word has been derived the word "patent" in its present-day meaning.

LETTERS ON PRACTICAL SUBJECTS

[BY J. F. WINCHESTER*

The "Letters on Practical Subjects" as printed in MACHINERY is a department that probably receives more attention from the general reader than any other part of the paper. I do not mean by this that the other articles are not much read, or are not full of up-to-date information, but that the average reader is not generally interested in many of the lengthy articles on special subjects. Lengthy articles on special subjects cannot be eliminated in any mechanical paper, however, for it has to provide for a wide diversity of interests, and any special article is bound to interest a class which receives it with pleasure and makes a detailed study of it, no matter how remote it may seem to mechanics in the general lines of work.

I have met men who have passed over some of these special articles without a thought that they contained information that might be of value to them, but who after a month or two would find a comment in "Letters on Practical Subjects" and then realize that they should look up their back copies and read the article carefully.

To my mind this department of MACHINERY is to the busy mechanic what the financial review or current events column in the week-end daily paper is to the busy business man, for in it he finds condensed information that he can easily assimilate and apply to his problems. Its columns recall past experiences of men, they give up-to-date shop practice and kinks that are applicable to almost any machine shop, and induce men to relate their experiences, who if called upon for a lengthy article, would decline.

Some of the articles in the December number of MACHINERY were especially interesting to me as they brought out points in an indirect manner that I have discussed with men both in and out of the shop. One thought brought out in "A Comment on Quarter Turn Belting Alignment," was on the value of a technical education to a mechanic, a subject that is usually thoroughly discussed by the mechanic who is taking an evening school or special correspondence course and the man who believes that he can solve his problems in a practical manner, as the millwright did, or leave them to the foreman. Practical men with an aptitude for their trade solve many perplexing problems under probably as unfavorable circumstances as the millwright did. Yet this example shows how considerable time, money and energy would have been saved if those concerned had devoted only a small amount of time to technical study of the problems affecting their trade.

The letter "Comparison of Selling Methods" brought out an interesting phase of the business side, a side that probably only a small percentage of the readers come in intimate touch with, but one that, nevertheless, is of interest to us all. The cost of practically the same machines differed in favor of firm No. 1, which is a consideration that would swing the sale to it in a great many instances, for cost in many cases is considered before merit. The salesman of firm No. 2, however, appears to have been backed up by a modern service department. Engineering information such as is usually asked for in such instances, does not emanate from the sales force, but from the engineering force that constitutes a service department. It was the harmonious relations of these two departments that made the sale possible in this case. No far-sighted firm will object to paying an extra amount to such an organization, for it always has a corps of specialists to call upon to help and advise on any perplexing problems that arise. Mr. Henry speaks of twentieth century methods. Did he apply such methods in wishing to pay cash for the article? Is not payment in thirty to ninety days in such cases considered cash? And is not the prestige that comes from meeting payments when they are due on such notes worth more than the prestige that comes from paying cash?

* * *

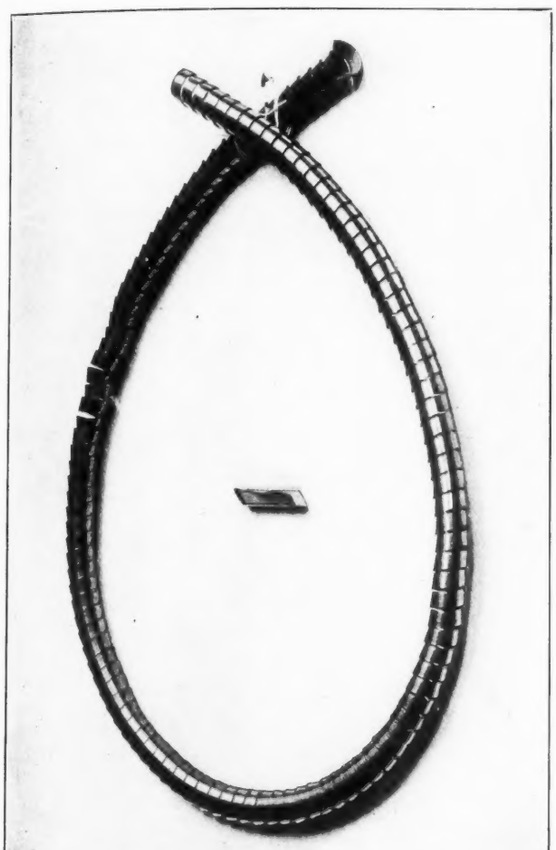
There is a great deal of difference between the salesmanship required to make a customer want to buy the goods you have to sell, and that required for merely selling them to him. It may seem like the same thing, but it isn't.

* Address: 469 Prospect Place, Brooklyn, N. Y.

NEW MATERIAL FOR LATHE TOOLS

BY ELWOOD HAYNES*

For some years I have been interested in searching for an untarnishable alloy which would take a cutting edge. After a number of researches on the alloys of copper with other metals, I found that practically all of these would become discolored in the presence of moisture and sulphureted hydrogen. Later, I turned my attention to the alloys of nickel with other metals, and as early as 1891, I succeeded in making an alloy of nickel with tungsten by melting the metals together in a small magnesia crucible. Later, alloys were made of nickel and metals of the chromium group. In 1899, I discovered that an alloy of nickel and chromium would resist oxidation to a most remarkable degree. I immediately afterward discovered that an alloy of cobalt and chromium would not only resist oxidation, but was extremely hard, and at the same time rather tough. In 1907, I took



A 3-8 inch Square "Stellite" Lathe Tool and Shaving weighing 1.2 Pound cut from a 2-inch Nickel-chrome Steel Bar in One-half Minute

out patents on the alloys of nickel with the metals of the chromium group, and also on the alloys of cobalt with the same metals. I have since had patents allowed on practically all possible combinations of cobalt with chromium, molybdenum, and tungsten. The alloys of cobalt and chromium, when properly handled, can be forged at a bright red heat, and be formed into table and pocket knife blades, as well as cold chisels and other useful forms. These alloys retain their brilliancy after polishing under all atmospheric conditions, and are not affected in the slightest degree by culinary operations nor by fruit acids; they are likewise immune to hydrogen sulphide and other corrosive gases.

About two years ago I became interested in the employment of alloys of cobalt with chromium and other metals in the manufacture of lathe tools. After numerous tests and experiments, an alloy was produced which shows most remarkable qualities in this respect. Either molybdenum or tungsten is added to the cobalt-chromium alloy to act as a hardener. These alloys are usually cast in the form of square bars which need only be ground to form to fit them for immediate use. They are held firmly by means of a tool-holder, and have shown an endurance under high speed which is truly wonderful.

A few practical examples will perhaps indicate the qualities of these alloys when employed for lathe tools. First, a high-speed steel tool, made from a ⅜-inch square bar of what is known as "dollar" steel, was employed in turning cast-iron gears to form. These gears were very hard, and afforded a severe test for lathe tools. The "dollar" steel would do about half the turning on one of the gears without sharpening. A "Stellite" tool of the same dimensions turned 41 of these gears to form, and was still in good condition. The high-speed "dollar" steel turned 26 gears to form in ten hours, while the "Stellite" tool turned 49 gears to form in the same time. Numerous other tests were made in which the efficiency of the "Stellite" tool over high-speed steel was repeatedly demonstrated.

It was soon discovered that a lathe which would run with sufficient speed and power to tax high-speed steel to its limit, would frequently stop when a "Stellite" tool was used, owing to the heavy load imposed; for example, a lathe driven by a three-inch belt would readily carry its load on back-gear, but would not run fast enough to reach the limit of the tool under any reasonable cut. If, on the other hand, the lathe was run on direct drive, either the belt or clutch would slip. Recourse was then taken to a lathe driven by a four-inch belt, but the same result frequently occurred. Finally, a test was made on a large "American" lathe driven by a six-inch belt through a system of gears. By means of this machine it became possible to drive at high speed without stalling the machine. In the lathe was placed a bar of nickel-chrome steel, and the lathe set at a speed which would just tax the cutting quality of the best high-speed steel tool. The lathe was then run at 2.66 times its former speed, and the "Stellite" tool applied. It removed a very smooth spiral shaving which showed a uniform blue color throughout its length. When the high-speed steel tool was applied at this speed, its edge was instantly destroyed. Repeated cuts were made with the "Stellite" tool, which cut off shavings weighing as much as 2.4 pounds, in one minute. Tests were later made on a hard nickel-steel bar which had been rejected because it "could not be worked". This bar was about 3¼ inches diameter, and about 30 inches long. It was placed in a heavy, Lo-swing lathe, and run at a speed which immediately destroyed the edge of a tool made of high-speed steel. The "Stellite" tool was then applied, which removed a heavy blue shaving from the bar at such a rapid rate that it was found difficult to manage the shaving. Within a few minutes nearly half of the bar was turned away, while the edge of the tool remained in excellent condition. Another test was made on a small lathe which was running normally at what was considered a fairly high speed for a high-speed steel tool. Under these circumstances, the lathe was turning regularly one steel bar in one minute and forty seconds. The high-speed steel tool was replaced by one of "Stellite," and the speed of the lathe increased until a bar was turned in 28 seconds. This could be done regularly, but the lathe operator afterward reduced the speed to one bar in 40 seconds. It will be noted that in this test, it was a question of *changing* bars rather than *turning* them. In another test not witnessed by the writer, but reported by a lathe builder, it was found possible to turn semi-steel gear wheels at the rate of only 40 feet per minute by means of a high-speed steel tool, while a "Stellite" tool turned them at the rate of 120 feet per minute.

In my opinion, the alloy will not, however, totally displace high-speed steel, since there are many instances in which rapid turning is impossible, owing to the nature of the work. When it is simply a question, however, of rapid cutting at high speed, "Stellite" certainly shows a great advantage over any high-speed steel ever produced.

* * *

In the movement for the safety of employes, fire prevention is one of the more important items. Over 5000 people are killed and 50,000 are injured annually in the United States as a result of fires. Most of these are preventable.

* Address: 305 North Washington St., Kokomo, Ind.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

FINISHING MACHINE PARTS

While it is true that "finish" is a distinct aid to selling a machine, it is equally true that the longer the machine retains its original appearance, the easier it will be to get "repeat" orders. It is not sufficient to see that a machine is given the proper quantity of filling; the filling must be applied in such a way that it does not peel off and leave a rusty surface to spoil the appearance. The writer has often marveled at the lack of care which is evidenced on the part of some machine tool builders in this respect, as it is by no means an unusual sight to see large areas of filling stripped off a machine. Such cases show that the manufacturer is unacquainted with the fact that paint will not stick to a rusty surface; this is particularly true if that surface happens to be somewhat damp at the time that the paint is applied.

At this point it will not be out of place to cite the practice of certain British machinery builders in finishing their products. The method may be old, but if so, there is sufficient evidence that a recital may "bear fruit" in refreshing the memory of those who do not use it. The method is simply that of painting the castings immediately after dressing off the sand in the foundry, one coat of paint being sufficient to protect them up to the time of their appearance in the machine shop. There is, of course, no necessity to waste paint on parts that are to be subsequently machined.

As time goes on, there seems to be a tendency to modify the design of many classes of machinery to avoid what is termed "unnecessary polish." To some extent, this is right, but there are cases where the application of paint instead of polish goes a long way toward spoiling the appearance of the machine. This is particularly true of the parts around the tools, where the chips exert abrasive action upon the paint; what is the use of painting these parts if the paint will not last? Of course it would require a lot of time to machine such parts, but if we revert to the old practice of grinding and polishing, which is quite as cheap as painting if the cost of filling, rubbing down, and varnishing is considered, the expense will not be great. Here, again, the practice of a certain British firm may be cited. All of the parts subject to damage from chips or from the overflow of oil are finished straight from the black by sand blasting. Care is taken to use nothing but an extra fine facing sand in the foundry, so that a good smooth surface is produced on the castings. The hardened work is treated in the same way on parts that are not to be subsequently ground. This firm also makes a practice of sand blasting the heads of set-screws instead of coloring them in some way; set-screws finished by this method are not marred by a wrench to the same extent as those having colored heads.

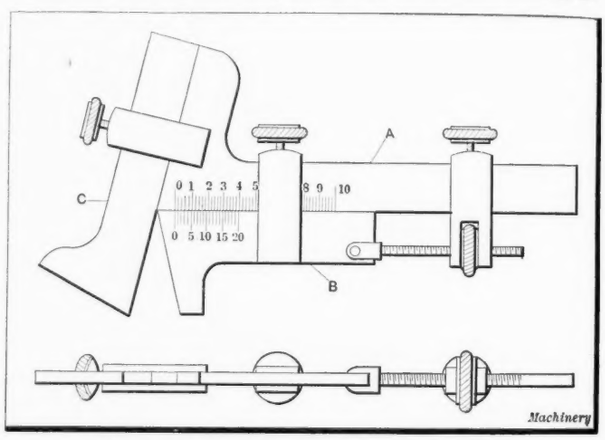
If one is to regard finish from the point of view expressed in the editorial in the November, 1912, number of MACHINERY, *viz.*, as "an outward manifestation of the quality of the materials and workmanship put into a machine," it is to be feared that some machine tool builders would make a rather poor showing. It does not necessarily follow, however, that a badly finished machine is poorly constructed. Every argument has two sides, and there are certain British firms which make a boast that no unnecessary time or money is spent on finishing machines. There are also purchasers who declare that they do not want "fancy finish" which they must pay for. One of the former goes to great extremes; for quality, his reputation is the best, for appearance the worst. Not only does this manufacturer limit the finish on his machines to one coat of paint, but no time is spent on fancy shapes. Every consideration is given to the form most convenient for the molder, even to the extent of leaving sharp corners in a great many places. If a gear guard can be produced more cheaply from sheet metal, no neat cast-iron guards are allowed to grace the machine. Homogeneity of design is of no consideration whatever, as box forms and ribbed forms are indiscriminately intermingled. Chucking pieces are left on, as it would cost money to remove them from the work. But here is the rub. Without a doubt, this manufacturer would increase his sales—aside from his particular established trade—by improving the appearance of his products. But the argument is advanced that a machine which is equal to the service required of it, is not the best available on the market unless it is the cheapest. This manufacturer has failed to find that the dictum that the workman takes more care of a nicely finished machine is true in his own shop; hence it is likely that it will not be true in other shops. He is undoubtedly losing by his stand, but being an altruist he won't give way, for he declares that the right must ultimately conquer. His motto is "What is right looks right." Now here's a point worthy of discussion. How far is it desirable to carry finish and art in the design and construction of machinery? Indeed, has art any place in modern manufacturing? The writer has considered the pros and cons of this problem and has personally arrived at the conclusion that he has arrived at no conclusion whatever. Can others help?

CAMERONIAN

AN IMPROVED GAGE FOR TWENTY-NINE DEGREE THREAD TOOLS

The purpose of this article is to describe a gage for the measurement of the 29-degree thread tool, so that an accurate tool may be made for cutting these threads. The fixed gages for this purpose do not provide for the degree of accuracy that is often necessary, for they do not give the width of the point of the tool exactly. A variation of 0.001 inch or more often exists, and although this cannot be seen by the eye, it is sure to give trouble—especially in the case of a hardened worm.

The remedy for this difficulty was devised in the gage shown in the illustration, a description of which follows. The gage



Improved Form of Gage for 29-degree Thread Tools

consists of a main piece *A* on which the slides *B* and *C* are made adjustable. The head of *A* carries a clamp for *C*, the piece *C* being adjustable so as to extend along the side of a long tool, thus insuring a square point on a tool of coarse pitch. This blade *C* is held to the correct angle by the front face of *A* which is ground to the proper angle with its base. The adjustable slide *B* is controlled by a clamp and an adjusting screw. The front edge of *B* is ground in such a manner that when the vernier reads zero, the space enclosed by *B* and *C* forms a sharp 29-degree angle. The gage is easily set for the different widths of tools by means of the vernier, which is one inch long and provides sufficient adjustment for all worms ordinarily met with. A point in favor of this tool is that it is only 1/16 inch thick. This does not permit any canting of the tool in the gage. Another important point is that the end of blade *C* is ground to the proper angle and can be easily removed and used as a gage for the purpose of setting the tool in the lathe.

This gage finds its field of usefulness in measuring thread tools of the "Acme" or "worm-thread" type, in measuring cut-

ters for the thread milling machine, and as has already been stated, as a gage for setting the tool in the lathe. In this connection the method of figuring the width of point for the tool for these two styles of threads might be mentioned. The "Acme" is not so deep as the "worm-thread" and so, for a given pitch, it is wider on the top of the thread, a difference of 0.0357 inch in the case of a one-pitch thread. For the "Acme" thread, which is of the same depth as the corresponding square thread:—

$$\text{Width of point of tool for screw thread in inches} = \frac{0.3707}{\text{Number threads per inch}} - 0.0052.$$

$$\text{Depth of thread in inches} = \frac{1}{2 \times \text{No. threads per in.}} + 0.010.$$

For the "worm-thread," the same rules will not apply. For this thread:

$$\text{Width of bottom of screw thread} = \frac{0.310}{\text{No. threads per inch.}}$$

$$\text{Depth of thread} = \frac{0.6866}{\text{No. threads per inch.}}$$

A common mistake is to set the top face of the tool, when used in a lathe, parallel with the axis of the worm to be cut. The proper way is to set it at right angles to the lead of the worm, thus making a cut of the same width as the tool, which is impossible if the tool is set as first described. This gage is intended to be used more as a piece of the shop equipment than as an individual tool to be owned by the workman. The vernier may be cut accurately enough in any good milling machine, and a good mechanic should be able to make this tool at a reasonable cost.

EVERETT CHIPMAN

Beverly, Mass.

A DIFFICULT BORING OPERATION

There is probably no class of work that taxes the ability of machine shop superintendents to a greater extent, than a job which is beyond the capacity of the shop's equipment. In most shops, however, work of this nature is constantly met with and were it not for this fact, the workmen in such establishments would become mere automatons instead of skilled mechanics. It is generally found that the ingenuity of mechanics is far more highly developed in shops where the facilities are limited and the work varies to such an extent that all production problems must be carefully planned and economically executed.

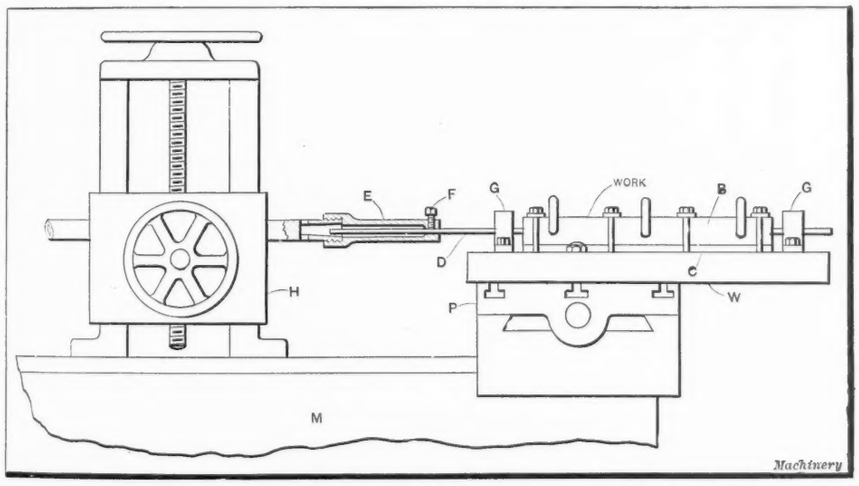


Fig. 1. Boring Mill equipped with Special Extension Sleeve for boring Long Work

We were recently asked to bid on a job which was decidedly perplexing because we had no boring mill of sufficient capacity to handle it. This made our bid so high, that we did not expect to receive the order; in due time, however, the order was received and handled in the following manner, which produced excellent results. The operation which caused the difficulty was that of boring a hole 1⅛ inch in diameter by 29 inches in length, which had to be finished within 0.001 inch of size. Our boring mill spindle had a travel of only 19 inches, so that it became necessary to provide some special means of securing the additional 10 inches; to be on the safe side, we allowed 12 inches, the method by which this was accomplished being as follows: The work, which is shown in Figs. 1 and 2, consists of three parts, *A*, *B* and *C*, *A* and *B* being the side pieces and *C* the bottom plate. The arcs were roughed out in the milling machine and all of the pieces were accurately planed so that they would fit together properly. After being placed together as shown in Fig. 2, it was necessary to bore the 1⅛-inch hole through the entire length of the work as previously mentioned. The bottom plate *C* was not over ½ inch thick.

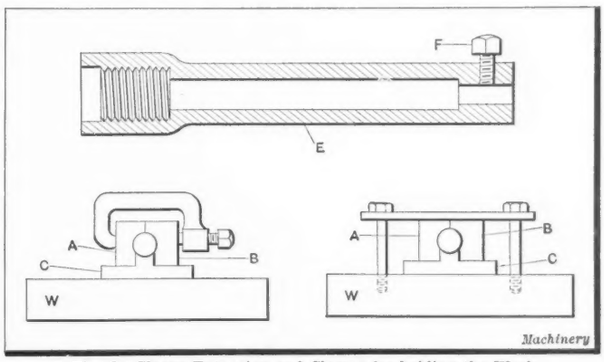


Fig. 2. Sleeve Extension and Clamps for holding the Work

The special equipment necessary for performing this operation consisted of two guides *G*, a bar *D*, ⅞ inch in diameter, and a sleeve *E*. This sleeve was very carefully bored, turned and threaded to fit the mill spindle as shown in Fig. 1. The hole through the sleeve was ⅞ inch in diameter at the front end, the remainder of the hole being chambered out to a slightly larger diameter. The bar *D* fitted accurately in the ⅞-inch hole in the sleeve and was clamped in position by the set-screw *F*. The work was set up on the extension table *W*, which was bolted to the platen *P*, the guides *G* having been previously placed in position and bored to receive the bar *D*. The method of clamping the three parts of the work *A*, *B* and *C* together is clearly shown in Fig. 2 and also the method of securing it to the extension table. The boring mill head *H* was previously set at the proper height in order to bore the guides *G*, and the sleeve *E* was then screwed onto the spindle. The holes for the cutters were now laid out and drilled in the bar *D*, three cutters of round stock being used. The bar *D* was then mounted full depth within the sleeve *E*, and with the cutters set in the proper position, the cut was started. When the spindle had traversed through its full 19 inches, the set-screw *F* was released, and the spindle backed out to the end of the bar *D* which remained in a stationary position in the work. The set-screw *F* was then tightened again and the cut continued for the remaining 10 inches. The mechanic who did this work was exceedingly careful and succeeded in finishing the hole very smooth, and well within the estimated time. We were allowed a limit of 0.001 inch but, as a matter of fact, the hole was finished within 0.00025 inch of the standard size from end to end.

Waterbury, Conn. WALTER E. FLADD

HOW TO FIX A BUSHING ON A PROPELLER SHAFT

In the December issue of MACHINERY, S. H. S. wished to learn of a satisfactory method of fixing a bushing on a propeller shaft. The writer would suggest putting a zinc

ring or bushing between the outside bushing and the propeller, as he believes that the loosening of the bushing referred to is due to a chemical action between the salt water and the bronze. This method has been used in a case where the zinc bushing was mounted on an axle steel shaft in a bronze bushing, and gave very satisfactory results where the propeller was running in salt water.

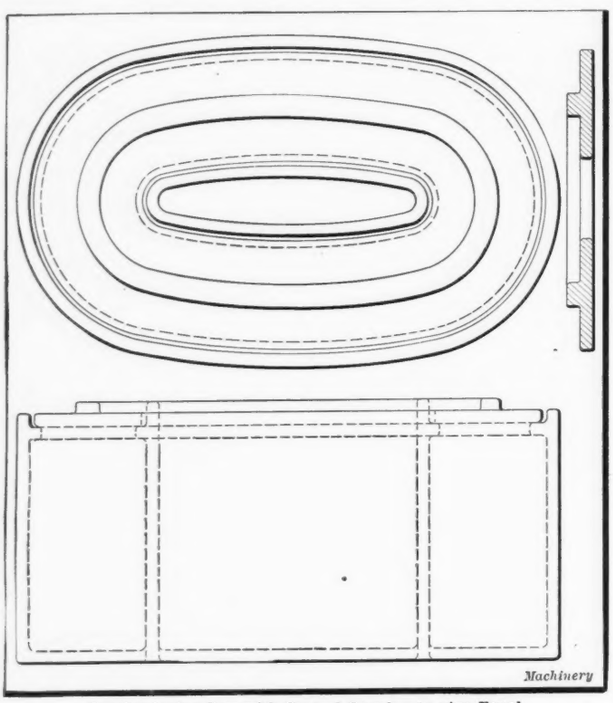
G. BRUUN

Wilkinsburg, Pa.

A CASEHARDENING BOX

The illustration presented herewith shows a novel design of casehardening box which is provided with a central space which allows the heat to be applied from both sides. By this means it is possible to bring the work to the required carbonizing temperature much more rapidly than when the regular type of casehardening boxes are used. The box shown in the illustration was made for use in casehardening piston pins and similar machine steel parts, but the same design could be used in making casehardening boxes for a variety of other purposes.

Experience has shown that the shape of this box is extremely satisfactory both in handling and packing in the heating furnaces. The boxes are made of steel castings, as this construction has been found to last longer and stand the intense heat for a longer period of time. The cover is ribbed and the double walls of the box add greatly to its strength.



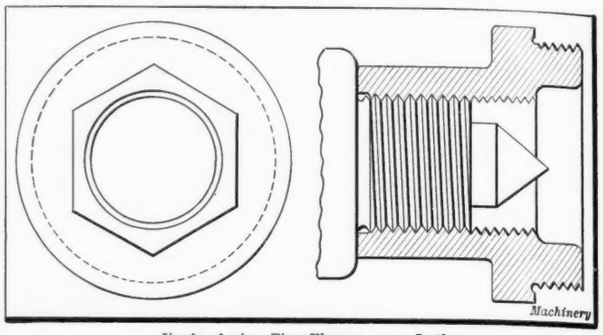
Casehardening Box with Central Opening to give Equal Distribution of Heat

Experience with this box has shown that the increased uniformity of heat distribution is the means of securing a much more uniform product, as the depth to which the work is carbonized is very nearly the same in all cases. There is also a saving of carbonizing compound and fuel because the heat enters to all parts in a much shorter time than is required where the ordinary type of casehardening boxes are used.

M. W. W.

A DEVICE FOR FACING PIPE FLANGES

The illustration shows a very simple arrangement for facing pipe flanges. The device is threaded internally to screw onto the lathe spindle and externally to receive the work, and is made from an iron casting with a hole through the center, bored and threaded to screw onto the spindle of an ordinary engine lathe, as shown in the illustration. The outside is turned to form a collar or hub for the work to be screwed up against. The section of the device to the left of the hub is cast hexagon, in order that an ordinary wrench may be used to screw it on or off the lathe spindle. The part to the right of the collar is threaded to receive the work, which, when screwed up against the hub or collar, can be conveniently faced on the lathe. No truing-up is necessary, and the construction is sufficiently rigid for heavy work. The flange is released from the holding device by using a bolt in one of the holes, the bolt being struck with a block of wood to back off the flange. When the flange has no holes, there is usually a lug cast on the outside, against which a tool can find a bearing. This tool can then be struck with a hammer to back the flange off the jig. The writer has made these holders in sizes ranging from 4 to 14 inches, and uses them with satisfaction in one of the largest pipe and fitting shops in the city of New York.



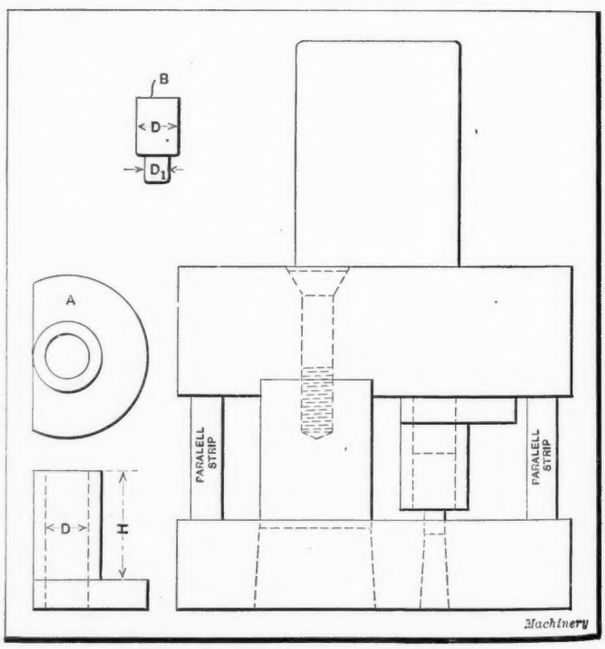
Jig for facing Pipe Flanges on a Lathe

Brooklyn, N. Y.

GEORGE E. OWEN

LOCATING PUNCHES IN TANDEM DIES

In making tandem dies, considerable trouble is often experienced in getting the small punches to line up properly with the holes in the die. This is especially true when the punch-holders are made of cast iron, as the sand-holes and soft places cause the drill to run out of square, which frequently makes the method of spotting holes through the die impossible. Another method of doing this work consists of placing a jig button on the punch-holder in exactly the same position as the hole in the die with which it is to mate.



Method of Locating Punches in Tandem Dies

The punch-holder is then set in a lathe and the button is made to run dead true. The button is next taken off and the hole is drilled or bored to the required size for the shank of the punch. This method requires very careful measurements to be made which, of course, involves a considerable amount of time.

The method to be outlined in the following description does

not require any measurements to be made, and the writer has found it convenient to make the shanks of punches of some standard size, as 3/16, 1/4 inch, etc. The first step is to make the guide *A*. Satisfactory results can be obtained with guides made of cast iron, although it would be better to make them of steel, hardened and ground. The important point is to get the guide hole square with the bottom of the flange; the height *H* should be ⅛ of an inch less than the height from the surface of the punch-holder to the end of the punch, and the wall around the hole is best made ⅛ inch thick. The flange is made about 1½ inch in diameter by ¼ inch thick and is cut away on one side to enable a hole to be made close to a large punch.

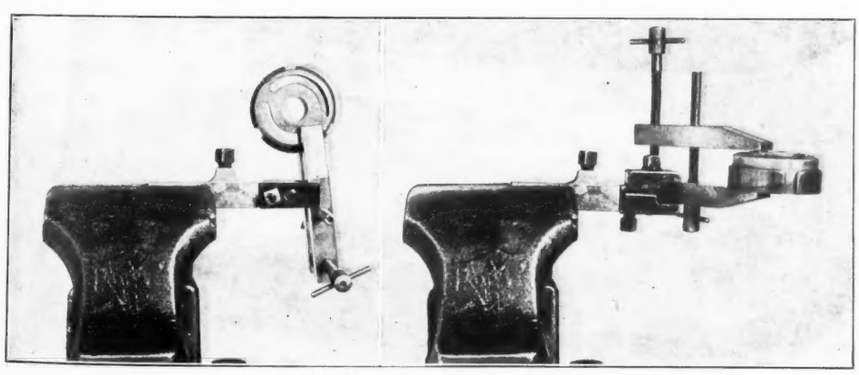
The hole in the guide is the same size as the shank of the punch which is to be carried by the punch-holder. The next part to be made is shown at *B;* it consists of a small piece of cold-rolled steel about ¾ inch long. The large diameter *D* is turned so that it will push into the guide without shake, and the small diameter D_1 so it can be entered into the hole in the die with a light tap. The small end is made about ¼ inch long and the large end ½ inch in length.

In setting up a job, the small end of the piece *B* is fitted into the die and the large end into the hole in the guide, as shown in the illustration. The large punch is next fastened in the holder and then lowered into the die. Two parallel strips are then placed between the die and punch-holder, which are of sufficient height to keep the holder from striking the guide. The guide is then drawn up against the punch-holder to which the flange is secured with two parallel clamps. The die is now removed and draws the pilot from the guide; the holder can then be turned up and spotted through the guide with a drill of the proper size to fit the hole. The hole is drilled to the required depth and of a diameter 1/64 inch smaller than the required size, the final finish being obtained with a rose reamer. This type of reamer is used to prevent scraping. If the reamer is a proper fit in the hole in the guide, the hole in the holder will be absolutely square with the surface and line up exactly with the hole in the die. This operation must be repeated for each hole that is required, and after the method has been used in a shop for some time, the necessary guides and plugs for any size of punch will have accumulated, thus saving a considerable amount of time and labor in making punch-holders.

Baltimore, Md. JAMES BARKER

PARALLEL CLAMP-HOLDER

In filing out irregular shaped dies, it is important for the diemaker to have his work held in such a manner that he can reach it conveniently and also see the layout he must follow. For this purpose the average diemaker uses specially constructed parallel clamps in connection with a bench vise.



Figs. 1 and 2. Vertical and Horizontal Positions for filing out Slots in Die

These clamps hold the work securely in place while it is being filed, and a special attachment provides for adjusting to any desired position.

Figs. 1 and 2 illustrate a handy form of clamp-holder for this purpose. It will be seen from these illustrations that the work can be held in a variety of positions so that it is possible for the diemaker always to work under the most favorable conditions. With this type of holder, any form of toolmakers' parallel clamps can be used. This, in itself, is quite important, as it does away with the necessity of using a specially constructed clamp for the purpose of filing out dies. The design will be readily understood by referring to Fig. 3, where it will be seen that the screw *A* allows the position

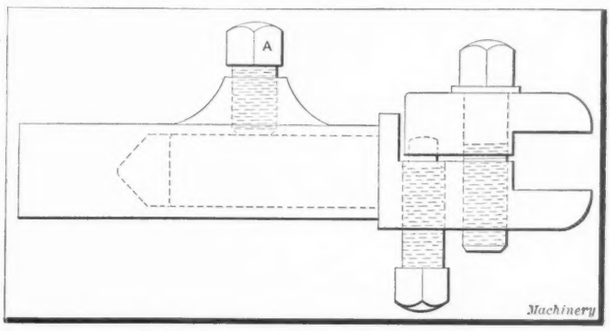


Fig. 3. Design of Holder for Parallel Clamp

of the clamp to be adjusted as desired. The tool is of a compact form and takes up very little room in the tool case.

Waterbury, Conn. CHARLES DOESCHER

COMMENT ON PATTERN COLORS

Mention was made in the November issue of MACHINERY, of a uniform system of painting patterns for steel castings that has been adopted by the Steel Founders Society and the American Society for Testing Materials. It appears that the selection of red for the pattern color of sections that are to be finished is ill-advised, because it is at variance with the almost universal use of colors on patterns. However, this objection would not be so serious if the system could be adopted by founders in other lines. It does not seem possible, however, that the patterns used in other than steel foundries will be changed in color, and if two distinct systems are to be used the natural result will be that a matter which is already bad enough, will be still further complicated. There seems to be no logical reason why patterns for different metals should be colored according to different systems; all patterns should have the same system of colors.

The most generally accepted pattern colors seem to be yellow for sections that are to be machined, and black for sections that are not to be machined. These colors are now so generally used that an experienced molder recognizes them instantly. Red is the generally accepted color for core-prints and stop-offs, and serves as an order to the molder to use particular care to see that these parts are properly formed. Core-prints painted yellow on the ends, indicate that the cored section is to be machined, and core-prints painted black on the ends indicate that the cored section is not required to be machined. Core-boxes are painted the same as patterns—prints red and body part yellow or black, to indicate where the castings are to be machined and where they do not require machining. Stop-offs are painted red all over and are readily distinguished from core-prints.

Founders and molders should understand that the sections of a casting corresponding with yellow sections on the pattern, must be clean, sound and free from defects; otherwise much unnecessary work will be required to get the casting into the desired condition. Particular care should be taken to have cores made in black boxes produced in such a way that the cored sections will be true to the pattern, for it is particularly annoying to have to machine castings when special provision has been made to have them come out correctly. Where a uniform system of pattern colors is used, a molder can change from one class of work to another without the difficulty of familiarizing himself with a new system. The preceding, concerning precautions that must be taken, will apply in all

classes of founding if a uniform system of pattern colors is used. This is but one of the numerous points in favor of uniformity.

J. R. RAND

Springfield, Mass.

SECTIONING DRAWINGS

In drawing assembly views, it is often necessary to show large portions of a machine in section. The cross-hatching method is tiresome and time-wasting. A satisfactory method of showing cross-sections, which is used in a large plant, is as follows: A tinting ink is used made from ordinary black Higgins ink with sufficient alcohol added to thin it. A test may be applied to some white paper. When the ink dries a light brown, it is of the proper constituency. This ink or paint is applied to the reverse side of the tracing on the parts which are to be shown in section, using a small camel's hair brush. On the blueprint this sectional view shows a cloudy bluish white, which is very readily distinguished.

New Britain, Conn. J. M. HENRY

[Another method, equally simple, which gives very similar results, is to merely rub over the parts shown in section on the back of the tracing with a soft pencil. On the blueprint this will also show as a bluish white. The pencil method has an advantage over the ink or paint method, as the latter has a tendency to wrinkle the tracing cloth if the thin ink is applied too liberally.—EDITOR.]

TOOLS FOR FITTING TUBES TOGETHER

The writer once designed a fixture and tools for use in milling the ends of tubes, when making joints in bicycle frames, and as they possessed some features of novelty, it is thought that they might be of interest to readers of MACHINERY. The general plan of the fixture and tools is shown in Fig. 1, a front and side elevation of the fixture in Fig. 2, and the form of cutter employed and the method of securing it in the milling machine spindle in Fig. 3.

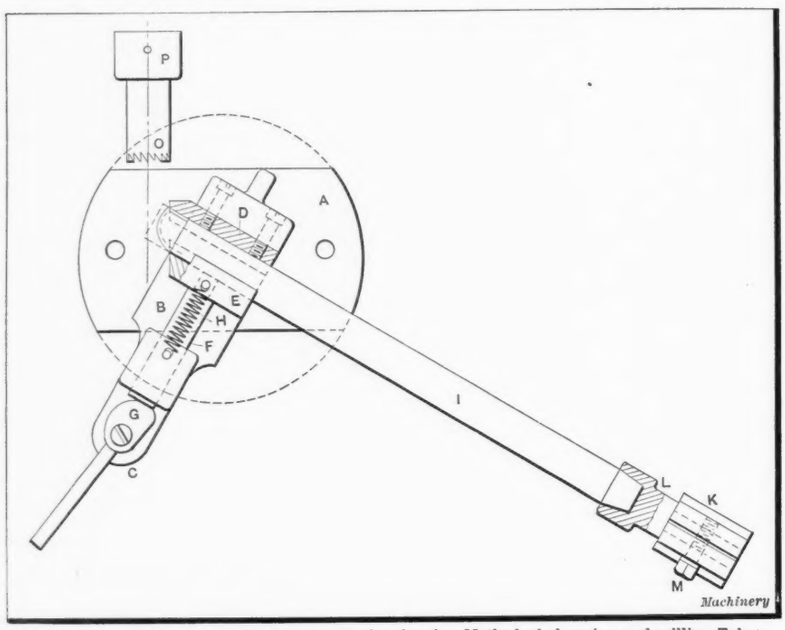


Fig. 1. General Plan of the Fixture and Tools, showing Method of clamping and milling Tubes

The tube-holding fixture consisted of a cast-iron frame, having a base-plate *A*, with an upstanding block *B* cast integral with it and having an overhanging lug *C*. A fixed jaw *D* was fastened to the block *B* by screws, and a movable jaw *E* was carried on a stem *F* which was movably mounted in the projection of the block *B*. A cam *G*, operated by a handle, was employed to move the jaw *E* against the tube to be milled, and a tension spring *H* operated to withdraw the jaw and stem when the cam *G* was reversed. A slot was milled in the block *B* midway between the jaws, and in it was secured a bar *I*, extending to the right. The bar *I* supported a block *K*, which had a socket member *L* secured to it by means of a suitable clamp and clamp-screw *M*. As most of the tubes had one end tapered, this form of socket member was most used; but some of the tubes were also formed with both ends milled, and special plug members, adapted to fit the clamp at one end and the tube at the other, were made for such tubes. Some were merely plain cylindrical plugs with square collars, and others had collars formed at an angle, according to whether the tube to be supported was milled on a bevel or was merely a square-ended blank tube.

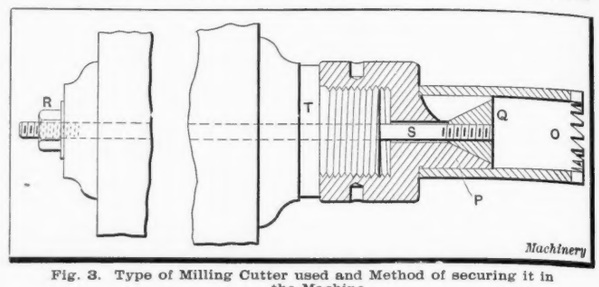


Fig. 3. Type of Milling Cutter used and Method of securing it in the Machine

In making tubes of different degrees of bevel, it was found desirable to make a fixture for each different bevel, so that no inaccuracies would be introduced in changing the fixtures from one angle to another. By making the base-plate *A* circular, as indicated by the large dotted circle, it was found that considerable pattern work was saved. All of the castings were made with the circular base-plate, and segments were then sawed off to obtain the form shown in Fig. 1, or forms similar to it but at different angles The fixtures were arranged for different lengths of tubes by changing the position of the block *K* on the bar *I*. This block was secured on the bar by a dowel pin and screws, and each length of tube was provided for by having a special dowel pin hole and special screw holes for it in the bar *I*. The fixtures were mounted on the knee of a hand milling machine, and the work fed to the cutter by means of the usual hand lever. The relative positions of the cutter and fixture are indicated in Fig. 1, and the line of feed movement of the work is indicated by the dot-and-dash line drawn through the center of the cutter. The type of cutter used and the method of securing it to the milling machine spindle are shown in Fig. 3. The cutter *O*, which is practically a hollow-mill, is gripped internally by means of three jaws *P* that are formed by making radial saw cuts toward the central hole. The jaws are expanded by means of the wedge *Q*, which is drawn against them by tight-

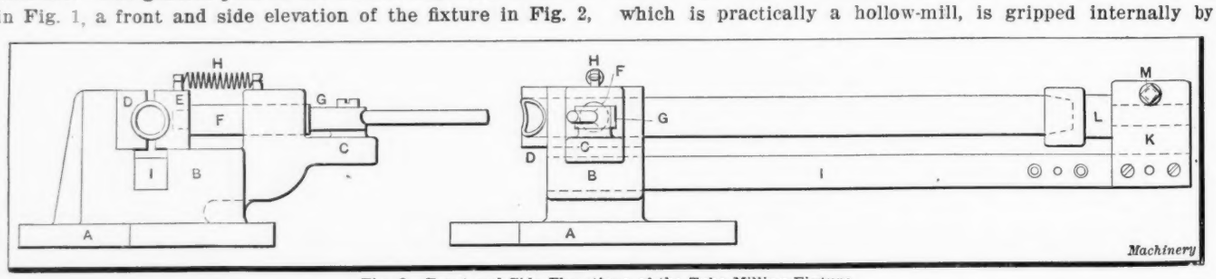


Fig. 2. Front and Side Elevations of the Tube Milling Fixture

ening the nut *R* on the threaded rod *S* in the spindle *T*. The chuck is screwed onto the nose of the milling machine spindle by means of a spanner wrench. C. D. K.

BENDING APPLIANCES FOR SHEET-STEEL PANELS

There are various methods in use for bending sheet-steel plates which have been made necessary on account of the fact that many types of bends cannot be produced satisfactorily with the ordinary bending rolls. For this reason, various appliances have been devised for producing special kinds of work. Cast-iron bending blocks are often made, and

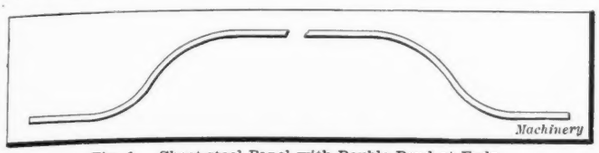


Fig. 1. Sheet-steel Panel with Double Bend at Ends

will soon pay for themselves where a quantity of work has to be bent to a standard shape.

Fig. 1 shows a sheet-steel panel which is made with a double bend at each end. The work of producing these panels was a matter of considerable difficulty until the bending device shown in Fig. 2 was designed for use in this operation. Referring to the illustration, the method of using the machine may be briefly described as follows: One end of the stock is placed against the block *D* and secured in this position by the clamp *B*. It is then bent over to the position indicated by full lines at *A;* this forms the first part of the bend. The movable block *C* is now brought over to the position indicated by the dotted lines, and is clamped in place by the arms *E*. The free end of the stock is then brought back to a vertical position, thus forming the second part of the bend. The work is now released from the machine and the bends at the opposite end are formed in exactly the same way.

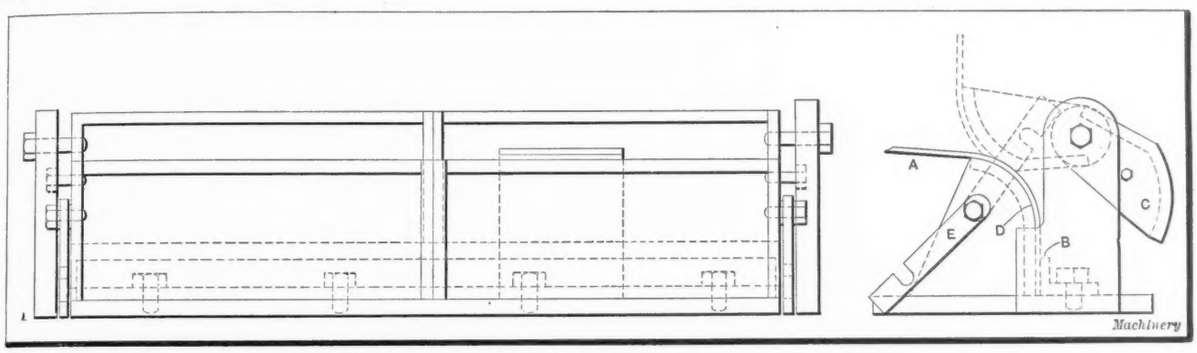


Fig. 2. Machine designed for Rapid and Accurate Duplication of Double Bends

This appliance has been used by the writer for a considerable length of time and has proved a very satisfactory method of producing these sheet-metal panels. The thickness of the stock used is between 0.064 inch and 0.104 inch; 0.080 inch is the most common thickness used for making car projection panels which are required to have true curvatures. It is important to have the work securely held by the cast-iron clamp *B;* if this precaution is not taken, variations in the composition of the steel plates will lead to inequalities in the radii of the bends. The bend of the more ductile sheets will be different from that of the tough sheets, as the ductile material naturally bends more easily. Ductility is not always an advantage however, for if the sheets are too ductile, a greater amount of leveling has to be done. This leveling requires great care on the part of the workman, because the appearance of the panel will be ruined if he does not observe the necessary precautions. In order to secure the best results in leveling, the hammer should be used as little as possible, and never directly upon the material. The best method consists of using a hardwood block about 3 inches square and 12 inches in length. This block can be safely struck without danger of producing any indentations in the work. The sheet steel that is best suited for various bending operations should be of medium toughness. Such stock does not require the amount of leveling that is necessary in the case of extremely ductile sheets. Brittle and blistered steel sheets should always be avoided, as they are of an inferior quality, and when such sheets are subjected to bending, the ductile material tends to slip over the less ductile portions, thus causing the work to break.

FOREMAN PLATER

DRAW-CHUCK FOR PISTON-TURNING

An arrangement that brings the principle of a hook-bolt into machine tool design is shown by the accompanying illustrations. Fig. 1 shows a lathe spindle with a piston in place; *A* is a steel ring on which the open end of the piston is placed after being bored, this ring being forced onto a suitable spindle nose cap. The hook-bolt *B*, shown in detail in Fig. 2, hooks around the bosses *C* and a pull-back rod *D* with a handwheel on the end goes through the spindle.

When placing a piston in the machine, the handwheel *E* is turned in the direction of the arrow enough to allow the hook on the end of the rod to pass around the bosses, and is then tightened, drawing the piston firmly against the steel ring *A*, and thereby bringing it into place. This arrangement

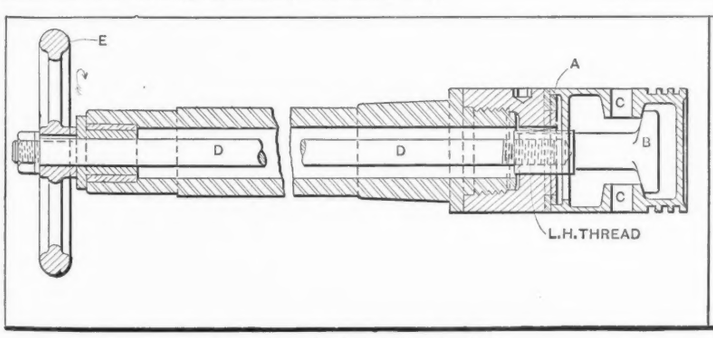


Fig. 1. Draw-chuck for Piston-turning

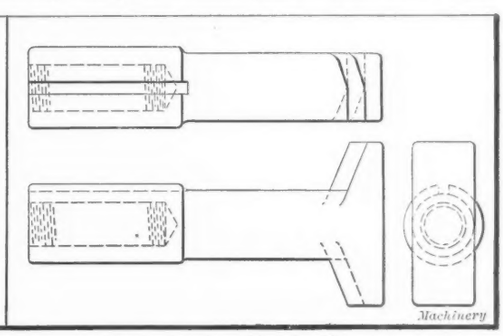


Fig. 2. Details of Hooking Clamps

obviates the use of the pin that is usually passed through the holes in the bosses *C*, and is considered superior, as it saves the operator the trouble of removing the pin every time he puts a piston on the machine. SERVER

BORING MILL ATTACHMENT

The engravings shown in connection with this description illustrate a convenient boring-mill attachment for use in crowning pulleys and band wheels. This attachment is of

particularly rigid construction and provides a means for the rapid production of duplicate work. The taper shank fits in the spindle of the boring mill, while the lever *A* is pivoted to the frame of the machine. Lever *B* is pivoted on lever *A*

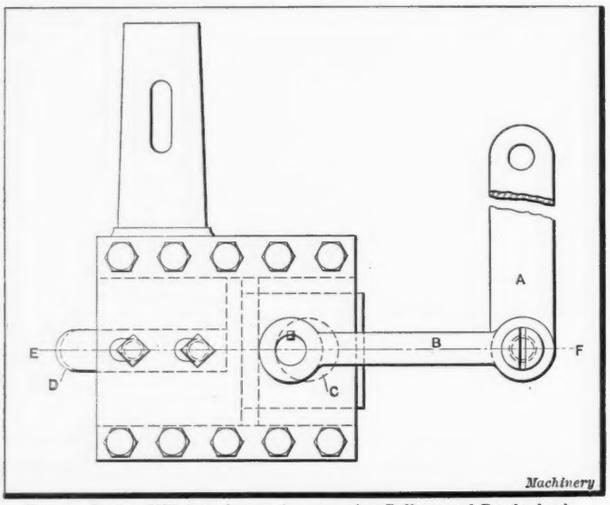


Fig. 1. Boring Mill Attachment for crowning Pulleys and Band-wheels

and carries an eccentric *C*, which fits into the tool-slide of the attachment. When the spindle of the machine is fed down, this eccentric gives the tool *D* the necessary transverse throw to produce the crown on the pulley. The arrangement of the

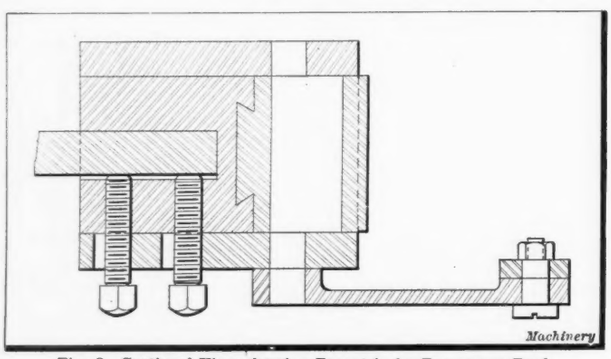


Fig. 2. Sectional View showing Eccentric for Transverse Feed

eccentric is such that the tool point moves away from the center of the pulley during the first half of the downward feed. At this point it is at the top of the crown on the pulley; it then begins to move toward the center of the pulley until the down stroke is completed. M. W. W.

DRILLING HOLES IN GLASS

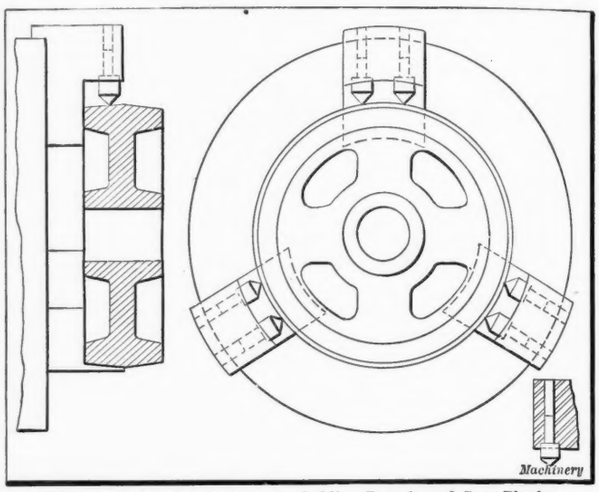
The writer has used a method for drilling holes in glass which differs considerably from the one published in the December, 1912, issue of MACHINERY. Instead of using a special tool, an ordinary twist drill was employed with satisfactory results. The edges were ground very slightly, to produce a cutting edge which had a negative or zero rake; the drill was driven at a comparatively slow speed. Screw cutting oil was used to lubricate the tool, just enough oil being used to keep the point of the drill from becoming dry; the oil formed a paste with the chips, which assisted in cutting the hole, the result being practically a case of "glass cut glass."

On one occasion it was necessary to drill a 3/16-inch hole in one hundred glass blanks ½ inch in thickness. The preceding method was used with a drill speed of 125 R. P. M., a sheet of blotting paper being laid under the blanks to take up any unevenness in the face of the glass. That this method proved successful will be seen from the fact that there were only three or four pieces out of the hundred that showed any checking on the side where the drill cut through. Another glass working job which sometimes comes to the machine shop, is that of smoothing off the edges of panes of glass which have been cut with an ordinary glass cutter. Anyone who has tried to do work of this kind on an emery wheel, knows of the difficulty that exists in finishing the work without breaking it. However, if such a job is done on a disk wheel, the edge can be straightened up and the corners rounded with surprising rapidity and without any particular danger of breakage.

Middletown, N. Y. D. A. HAMPSON

CHUCK JAWS FOR HOLDING DROP-FORGINGS

The accompanying illustration shows a type of improved chuck jaws especially devised for holding drop-forged gear blanks. The improvement simply consists in providing the regular chuck jaws with pointed gripping pins. In the case shown, the jaws are drilled and reamed with holes about ¼ inch in diameter. These holes are then counterbored at the end nearest the work to about ⅜ inch diameter. Pins are made to fit these holes; the parts of the pins that fit into the smaller diameter of the hole should be a press fit. The pins should be hardened, and the gripping end, which should have a taper of about 30 to 45 degrees on each side, should be ground to a sharp point and should be kept sharp at



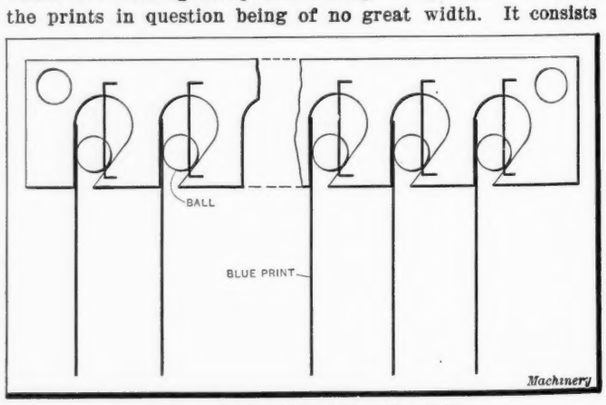
Improvement in Chuck Jaws for holding Drop-forged Gear Blanks

all times. The pins should be carefully lined up with one another. The device, when well made, will hold the gear blanks so tightly that there is no danger of slippage. Care must, of course, be taken to have the gear blank rest firmly against the face of the jaws. FRED FRUHNER

Milwaukee, Wis.

BLUEPRINT DRYING RACK

The apparatus shown in the illustration is employed by the writer for holding blueprints during the process of drying, the prints in question being of no great width. It consists



Rack for Holding Blueprints while drying

of a wooden rack with about thirty-six slots, of the shape shown in the illustration, cut in its under side; one side of each slot is vertical and one inclined at an angle of about 60 degrees to the horizontal, the two sides being connected by a circular arc. Each slot contains a small hardwood ball, which naturally tends to fall to the bottom or mouth of the slot. The width of this part of the slot, however, is less than

the diameter of the ball, so that the latter cannot drop out. Hence, instead of dropping out, the ball exerts a pressure on each side of the slot so that when the end of a blueprint is placed in position against the vertical face and the ball is allowed to fall to the bottom of the slot, the pressure exerted on the vertical face is quite sufficient to hold the print in place. To prevent the balls from falling out of the slots sideways, wires are secured to the rack opposite the middle of each slot, as shown in the illustration.

The two principal advantages possessed by this piece of apparatus are: 1. The facility with which the ball is flipped up out of the bottom of the slot to release the blueprint. 2. The fact that every particle of water is allowed to drain off the print without defacing it in any way whatever. This apparatus can also be employed in drying large blueprints, though in this case, it would be advisable to use two racks and suspend the prints from two points, in order to keep them as flat as possible. In this case, the two racks should be placed on an adjustable frame so that different sizes of prints could be accommodated. One of the racks could be fixed in position and the other made movable, one being arranged so that it is a little higher than the other. This precaution allows the prints to be so arranged in the racks that the bottom edges of the prints are not quite horizontal; the water on the prints will then flow to one corner and so drain away more readily than if the edges were horizontal.

Sheffield, England. GEORGE W. BURLEY

GENERAL DISTRIBUTION OF CATALOGUES

I certainly agree with your editorial note in connection with the letter from Yamatake & Co., Tokio, in reference to the general distribution of catalogues in Japan. It would be a great mistake for American machinery manufacturers to turn down these requests for catalogues, even though a large number do come from students. The writer was connected with the machine tool business in Japan long enough to secure actual orders from men who as students had been supplied with catalogues by manufacturers. It would be well, however, if manufacturers in America did realize that a large number of these inquiries were from students, and not bother their agents with follow-up letters as to whether the business was secured or not. JOHN S. NICHOLL

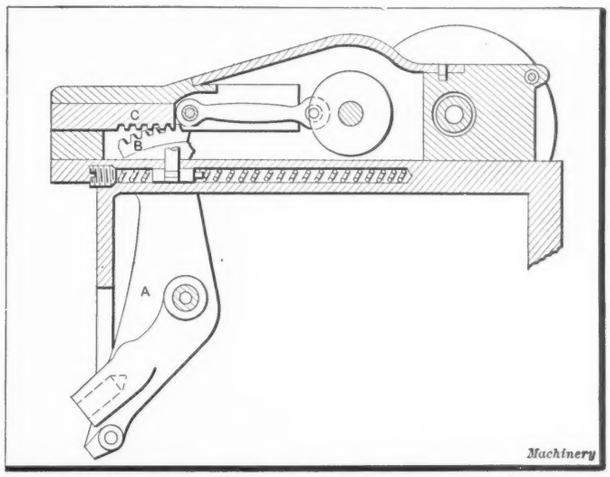
Boston, Mass.

TAKING OUT BACK SHAFT OF A B. & S. AUTOMATIC SCREW MACHINE

The writer wishes to offer a comment on a statement by Mr. Nevin Bacon in the November issue, relative to taking out a back shaft. Mr. Bacon states, "If a back shaft is taken out and replaced in such a manner that every gear does not mesh with the same teeth as it did before the shaft was removed, then the machine will be 'out of time' and the entire job will have to be set up again." Since the writer knows that Mr. Bacon has had experience in replacing back shafts on B. & S. automatic screw machines, it seems peculiar that he should make the statement that the job would simply have to be set up again to overcome the difficulty. Mr. Bacon will have to admit, upon second thought, that in case a back shaft is not properly replaced, the machine will not be in operating condition, because no matter to what extent an operator may change his job on the machine, all of the clutches, gearing, and cam-actuated engaging arms will refuse to do their part. All B. & S. automatic screw machine operators will agree with this statement—hence the criticism.

In connection with this discussion, the writer wishes to state that if the rack *C* is removed and is not replaced in mesh with the same teeth of the segment gear *B* on the bell-crank lever *A* as were in engagement before removal, the distance of travel of the turret tools will be different from that before the adjustment was made. An operator is often confronted with a screw machine job that gives trouble because the part to be made is too long for the distance between the spindle and turret, so that there is not sufficient clearance for the turret tools when tripping away from the work. In this case, it is advisable to mesh the teeth of the rack *C* with different teeth of the segment gear *B* than were previously in engagement; this will allow a greater distance between the turret and spindle and still permit the machine to be operated without danger of breakage. This method of production will effect a great saving over the cost involved in producing such pieces on a hand screw machine. J. HARMON

[Mr. Harmon is correct in his statement regarding the relation of the work to the timing of the back shaft, but should modify his statement in regard to the rack operating the turret. His statement applies to the Nos. 00 and 0 machines only; the No. 2 machine has an adjusting screw which provides for the use of tools of various lengths in the turret.



Mechanism of Turret Slide of a B. & S. Automatic Screw Machine

It should also be mentioned that in making such an adjustment of the engagement of the rack and segment gear, the stop for the rack must be set out in order to allow the rack to travel further back and thus increase the distance between the face of the turret and the chuck for the accommodation of longer tools. Such a method of increasing the capacity of the machine is but a makeshift at best, and its use is not to be recommended. While there is probably no danger of damaging the machine, this adjustment of the rack and segment gear creates a tendency for the rack to bind, which certainly is not a desirable condition in the operation of the machine.—EDITOR.]

TO BROWN RIFLE AND PISTOL PARTS

The following formula for browning rifle and pistol parts is offered by the writer because he has found that it gives very good results. The method of procedure is as follows: Coat the metal to be browned with a solution of copper sulphate, either by dipping or with a camel's hair brush. When the metal is well coated or plated with copper, wipe it dry with clean cotton waste or a cloth. Then apply ammonium sulphide solution by dipping or with a brush, being careful to cover all parts touched by the copper sulphate solution. After the ammonium sulphide has acted for about thirty seconds, dry the work by normal pressure on the surface with clean waste or a cloth. No heat is required for the above process.

The copper sulphate solution is made up as follows:

25 per cent copper sulphate, ($CuSO_4$)
74 per cent water, (H_2O)
1 per cent muriatic acid, (HCl)

The ammonium sulphide solution is made by dissolving chemically pure $(NH_4)_2S$ in water.

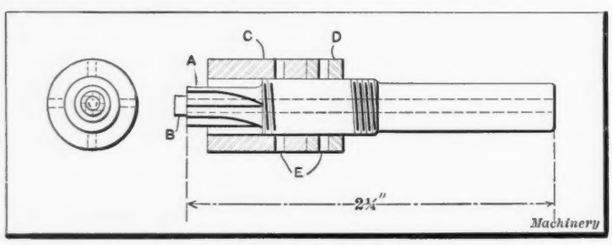
The color produced will be similar to the browning done at the Springfield Armory, and is due to the copper sulphide, produced on the outside surface of the copper plate previously deposited by the chemical action between the copper and ammonium sulphide. The copper sulphide is a stable compound and affords good protection to the metal browned in this way. The copper plating beneath the sulphide also provides a safeguard against rust. The same result could be used for browning other classes of work.

Hartford, Conn. CHARLES F. SCRIBNER

AN ADJUSTABLE COUNTERBORE

In the accompanying illustration is shown a counterbore which is adjustable as to the depth of the hole. It consists of the part *A* which has teeth cut on it for ½ inch of its length. Just above this is a threaded portion, ⅝ inch long, and above this, a straight shank, slightly less in diameter than the root diameter of the threaded part. A hole is drilled through the center of *A* into which is fitted the removable pilot *B*.

A collar *C* screws onto *A*, and the position of this collar is adjusted for the depth of the hole to be counterbored. A check-nut *D* prevents the collar from turning after being adjusted to the required position. The collar and check-nut are round and they are turned by a pin inserted in holes *E*.



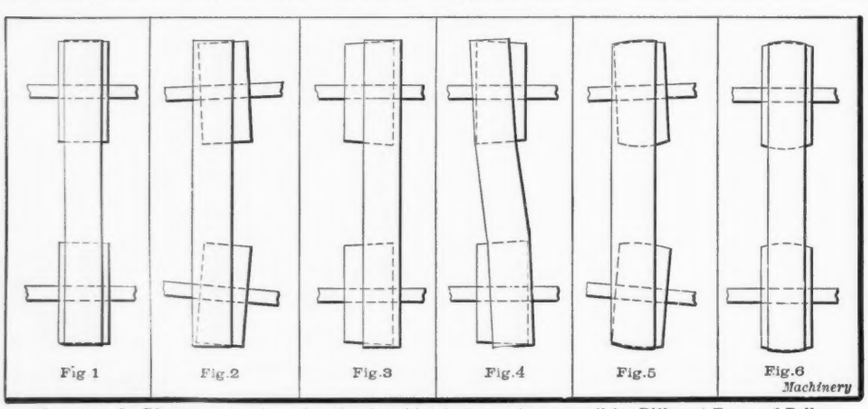
An Adjustable Counterbore

In use, the counterbore enters the hole until the collar reaches the work; this stops the progress of the cutter. This tool has been found very useful when two holes are to be counterbored in the same piece, but when these holes are on different surfaces and thus at different levels. In order to use the usual spindle stops, in such a case, two counterbores would be required and two spindles of the drill press. Several different sizes of semi-finished parts for these tools are made up in quantities and carried in stock ready to turn the cutter to size, mill the teeth, fit the pilot, harden and grind. They can thus be made up very cheaply. A. M. ROCHESTER

COMMENT ON DIRECTION IN WHICH BELTS TEND TO RUN OFF PULLEYS

In the October number of MACHINERY, T. J. C. states: "It is common experience, noted by all mechanics, that an open belt running over pulleys mounted on shafts in the same plane but out of parallel, runs to the 'high side'." The layout accompanying this discussion shows the shafts out of parallel and the belt on the "high side." The "high side" is the term applied to what is properly the longer distance between shafts that are out of parallel, and belts will not run to the "high side" but to the "low side" or shorter distance between the shafts.

Let us start with pulleys that are straight face and of equal diameter for the full width. When shafts are parallel and the pulleys are in line, the belt will run in its proper place on these pulleys. This condition is shown in Fig. 1. When the shafts are out of parallel and the pulleys are in average line, as shown in Fig. 2, the belt will run to the "low side" or the end where the shafts are nearer together. With cone-face pulleys—pulleys having a straight face but larger in diameter at one end than at the other—when the shafts are parallel the belt will run to the larger diameter. This larger diameter is the high part of the pulley, but is not necessarily the "high side," and it must not be confused with the term "high side" as applied to the alignment of shafting. Two conditions are possible for this case, as shown in Figs. 3 and 4. With crown faced pulleys mounted on shafts that are out of parallel, as shown in Fig. 5, the belt will run toward the "low side." When shafts are but little out of parallel, the tendency to run toward the "low side" will not be noticeable, for the crown will keep the belt at the center of the pulleys. The same results take place with shifting belts running from straight face pulleys on main shafts to straight or crown face tight and loose pulleys on countershafts or machines. Fig. 6 shows crown face pulleys in line on shafts that are parallel, and in this case the belt will run to the centers of the pulleys. The tendency is for the belt to run to the larger diameter.



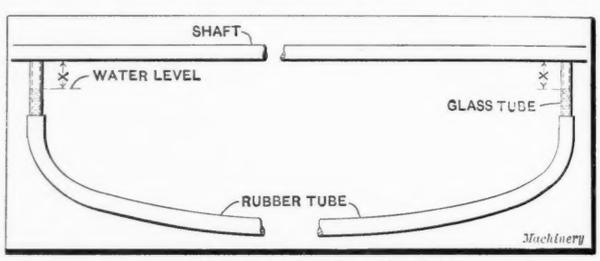
Figs. 1 to 6. Diagrams showing Direction in which Belts tend to run off for Different Types of Pulleys and Alignment of Shafting

In the preceding discussion, it has been assumed that the belts are straight and that both edges are the same length. Belts with one edge longer than the other will not run in their proper places on pulleys that are properly aligned on parallel shafts. Crown face pulleys should be the same diameter at both ends with the larger diameter at the center of the face. T. J. C. in his comment mentioned an open belt. The same general results will obtain with crossed belts but the lead will be affected to some extent by the crowding of the belts at the crossing point. J. R. RAND

Springfield, Mass.

METHOD OF LEVELING LINESHAFTING

Long lengths of lineshafting can be leveled by the use of the apparatus illustrated herewith, which will be seen to consist of a piece of rubber tube or hose that is long enough to reach nearly to the ends of the shaft which is being leveled. A piece of glass tube is fastened in each end, with six or eight inches projecting from the rubber tubing. Water is poured into the tube until it is nearly filled, the level at either end being situated in the glass tubes. Two small corks are then used to prevent the water from being spilled while moving through the shop.



Apparatus used for leveling Lineshafting

The principle upon which this apparatus works depends upon the well-known fact that water seeks its own level. Consequently, it is only necessary to place the ends of the glass tube against the lower side of the shaft and measure the distance *X* between the shaft and the water level in each glass tube. If the shaft is level, the distances *X* must necessarily be equal, and the amount of any inequality which is exposed is easily determined. Two men are required to level shafting by this method, one man taking measurements of the distance *X* at each end. This device can also be used to determine the level of shafting which passes through a wall, as the tube can be taken around so that the ends are brought into contact with the shaft on each side.

Fort Atkinson, Wis. E. L. WHITE

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

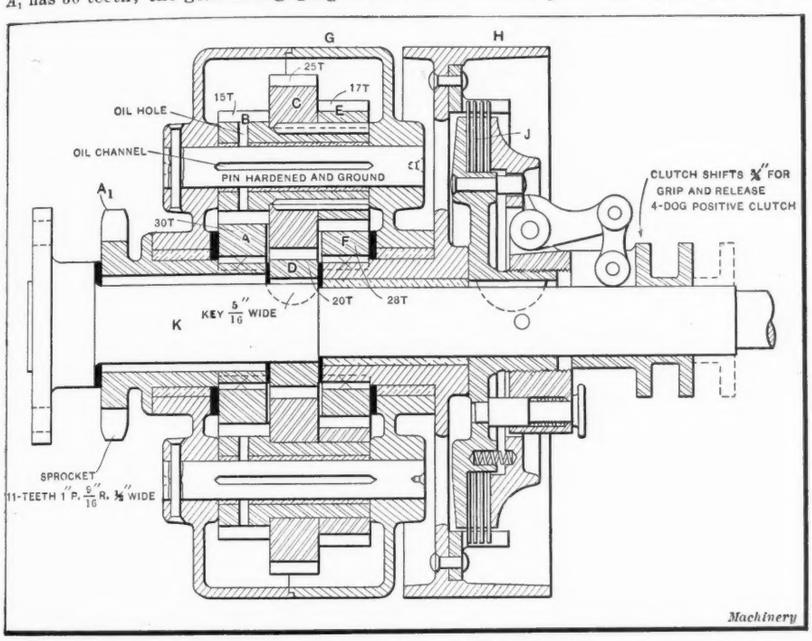
CAM GRINDING INDEPENDENT OF WHEEL WEAR

C. D.—Machines are available for grinding small gas engine cams accurately, but I have never seen a machine for grinding large gas engine cams that did not produce forms varying with the size of the wheel. Consequently, wheel wear vitally affects the shape of the cam. I would like to see a description of a cam grinding machine for large cams that produces fixed shapes independent of wheel wear.

If any reader can furnish a description of a special cam grinding machine that meets the want of our correspondent, we shall be glad to receive it.

SPEED RATIOS OF AUTOMOBILE PLANETARY GEAR

G. M. G.—The illustration shows an automobile planetary transmission gear which provides two forward speeds and one reverse speed. Gear *A* mounted on the sleeve with the sprocket A_1 has 30 teeth; the gear *B* engaging with it has 15 teeth; gear *C*, 25 teeth; gear *D* keyed to the shaft *K*, 20 teeth; gear *F* mounted on the extended hub of clutch drum *H* has 28 teeth; and gear *E* meshing with it, 17 teeth. By clutching the drum *G*, slow forward motion is communicated to sprocket A_1; by throwing in the clutch *J*, high or direct speed of A_1 is obtained; and by clutching *H*, the reverse motion of A_1 results. In the designing of this gear we have had considerable discussion and difference of opinion over the ratios that will be obtained, especially on the reverse. Will you kindly submit the drawing to the readers of MACHINERY as an example of interesting planetary transmission and let them calculate the ratios?



A.—The gear offers little difficulty as a problem in ratios when analyzed by the method that has been explained several times in MACHINERY, excepting that a supplementary calculation is necessary to find the reverse speed. However, it is offered for solution and answers are requested.

TO FIGURE THE RISE OF STEEP GRADES

A. L. D.—A garage here in San Diego, Cal., has a balcony for the storage of motor cars. The cars are driven up an incline to the balcony under their own power. The height of the balcony from the floor is seven feet ten inches and the length of the incline between perpendiculars is eighteen feet. The question is how to figure the ratio of lift to car travel. I claim that the length of the incline or hypotenuse of the angle made by the incline with the floor should be taken as one member of the ratio, but others say that in figuring grades the distance between perpendiculars is always taken.

A.—The distance between perpendiculars is always used in calculating all ordinary railway and highway grades, the grades being expressed as rise percentages of the horizontal distance. The percentage of rise in the case cited is 43.5 per cent. But in grades as sharp as this the car travels a perceptibly greater distance than that between perpendiculars, being in this case, nearly nineteen feet seven inches. Hence the rise should be figured in terms of the incline, or as the sine of the angle instead of the tangent as is the general rule.

PROVING NARROW-CAVITY DROP-FORGE DIES

T. C.—I recently sunk a drop-forge die for a bayonet, and have experienced great difficulty in securing a satisfactory lead proof from same. The bayonet is 13 inches long and 0.060 inch thick in the blade. I used a 0.015-inch shim between the dies to allow for air vent and heated the die so that it would melt solder before pouring the proof. I have tried lamp-black, powdered chalk and greases of different kinds to prevent adhesion of the molten metal; also lead and rosin, and six per cent tin in lead and babbitt metal with poor results.

Answered by J. W. Johnson, Revere, Mass.

The difficulty of obtaining a good lead proof from a narrow-cavity die, is sometimes caused by not having the sprue of sufficient size. The sprue should be large enough to hold the piece on the bar until forged; it should not be too long and should be smoothly finished and well chalked. If the lead is allowed to strike the gate and run into the sprue while proving, it will be chilled before it goes into the impression, and for that reason sometimes will not fill it out properly. Again, if the lead is heated too much, it will not run well. The lead should be clean; a good plan is to throw a little powdered rosin in the ladle before pouring, and skim off the top. The lead should be poured directly into the sprue in a steady stream and not too rapidly or it will choke. The piece of thin cardboard between the dies on each side of the impression is good to let the air out freely, but the resulting proof will not be exact, inasmuch as it will be thickened by the thickness of the cardboard stock. The dies should be well chalked all over the impression, the sprue and the gate, and it is well to warm the dies slightly also when the cavities are narrow. I have taken lead proofs as long as the one in question and have made the lead flow into cavities only 1/32 inch wide, or about one-half the thickness of the thinnest part of the bayonet. I think the cause of the trouble is in having too small a sprue in the dies.

* * *

NEW EQUITABLE BUILDING

The Equitable Life Assurance Society of New York has filed plans for a thirty-seven-story building, to cover the block bounded by Broadway, Pine, Nassau and Cedar Sts., New York, which will be the largest building in the world in point of floor area, although not the highest building. Its height—486.9 feet—will be considerably less than that of the Woolworth building in New York, which is about 750 feet. The new building will have forty-six public passenger elevators and will provide 1,100,000 square feet renting floor space. Announcement was made in the February, 1912, number of proposed plans for a building on this site—the site of the old Equitable building which was destroyed by fire January 9—that provided for a main structure of thirty-four stories surmounted by a tower of twenty-eight stories, making a total height of 909 feet. The plans for this building were not adopted, however.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

LEES-BRADNER THREAD MILLING MACHINE

The Lees-Bradner Co., Cleveland, Ohio, manufacturer of automatic gear generators, has recently placed on the market a line of thread milling machines designed by E. J. Lees,

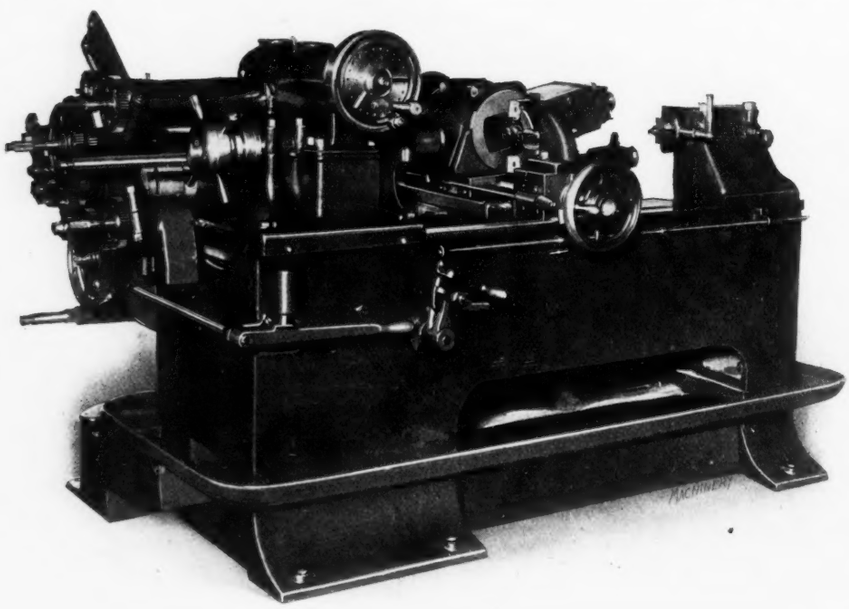


Fig. 1. Front View of the "Two-foot-six" Size Lees-Bradner Thread Milling Machine

which are shown in the accompanying illustrations. Fig. 1 shows a front view of the machine known as the "two-foot-six-size." This machine has a capacity for lengths of 2 feet 6 inches between centers, and will cut any lead from 20 threads per inch up to and including a lead having one turn in 96 inches. The swing over the cutter-slide is 10 inches, and over the ways, 16 inches. The thread milling is accomplished with a single form cutter, mounted on a spindle in a swivel head which has an angular adjustment of 180 degrees. The swivel head is set according to the angle of the thread to be cut, by means of graduations on the rear of the head and a vernier scale.

Driving Mechanism and Main Head

This thread milling machine is driven by one belt from the countershaft which runs on a cone pulley at the rear of the machine, having four steps as shown in Figs. 3 and 5. This cone pulley, through a clutch mechanism, drives the back-shaft which transmits power to the cutter and, through change-gearing, rotates the work and lead-screw. The machine is started by pressing down a lever which passes at right angles through the bed and connects with a clutch on the back-shaft. The quick return of the cutter-slide, which is in a ratio of 60:1, is controlled by a lever shown at the extreme left-hand end of the machine in Fig. 1. A hand lever fitting on the squared shaft extending from the left-hand end of the machine is used by the operator in setting the cutter-slide in the proper position in relation to the work when setting up a new job. When everything has been set for a certain part, however, this hand lever is not manipulated at all.

For cutting multiple threads, the work-spindle is indexed by a dividing mechanism shown on the left-hand end of the machine in Figs. 1 and 2. Plates having various numbers of holes are provided for the different indexings of the spindle required. The indexing of the work is accomplished by hand at the completion of each cut, when cutting multiple threads. The spindle is indexed by means of a worm and worm-wheel, the latter being held rigidly on the work-spindle itself.

The work-spindle is made from a hammered tool-steel forging, ground inside and out, and carries a draw-in spring chuck having a capacity for 2¾ inches diameter. The hole passes completely through the spindle so that work equal in diameter to the capacity of the chuck and longer than the capacity of the machine can be operated upon by letting it project from the rear end of the spindle. The work-spindle runs in gun-metal bushings, the front bushing being 8½ inches long by 4¾ inches in diameter, and the rear bushing, 5½ inches long by 4½ inches in diameter. The spring chuck, which is of the draw-in type, is closed on the work by the handwheel shown at the rear of the spindle in Figs. 1 and 2. When it is necessary to hold the work on centers, a center

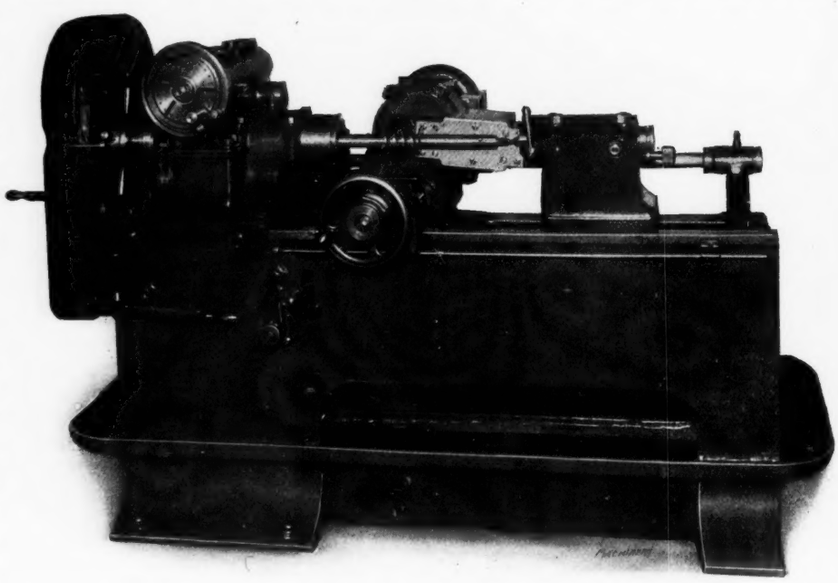


Fig. 2. Milling a Steel Worm One-inch Circular-pitch, Single-thread, in One Cut

which fits in the spring chuck is used for this purpose.

The Cutter-slide

The cutter-slide, which is moved longitudinally along the bed by the lead-screw, is provided with three bearing surfaces

of liberal proportions, see Fig. 5. A noteworthy feature in connection with this type of bed is the raised front which increases the depth of the bed and shortens the distance from the axis of the spindle to the bed, without increasing the swing. It also provides additional rigidity to the cutter-slide and tailstock. The drum in which the cutter-head proper rotates is of rigid design, and is cast integral with the cutter-slide.

The cutter-spindle is a vanadium steel forging, hardened and ground, and runs in a hardened and ground bushing. It is 1½ inch in diameter and is driven by a spur gear meshing with a gear made integral with the spindle and having a 3½-inch face. This cutter-spindle is so strongly built and rigidly supported that it will stand up to cut a thread having 1½-inch circular pitch in steel, in one cut. The absence of overhang of the cutter-spindle is one feature that is of prime importance in a thread milling machine which must take heavy cuts without chatter or vibration, and this is admirably provided for in the machine illustrated.

The depth of cut is obtained by moving the entire cutter-slide by means of the handwheel shown at the front of the machine. The means of accomplishing this adjustment is

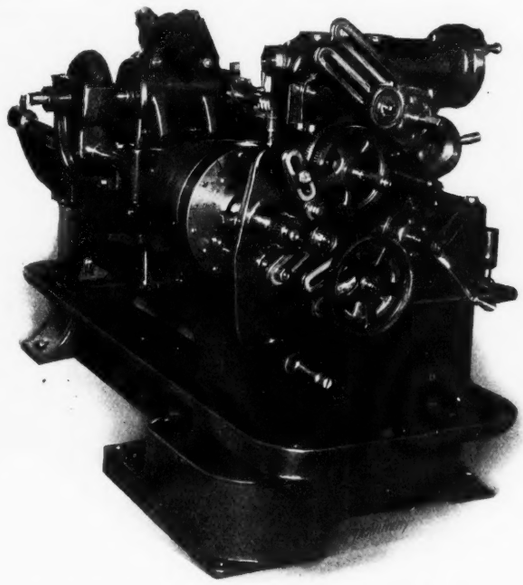


Fig. 3. End View of Thread Milling Machine showing Change-gearing Guard removed

worthy of special mention. The screw operating the slide (at right angles to the axis of the work-spindle) is stationary, whereas the micrometer nut is operated by a handwheel, and by an ingenious interlocking arrangement the cutter can only be brought in to the depth for which it has been previously set. This obviates the possibility of an operator making an error in this respect, which could easily occur in cutting a multiple thread if no provision were made for retaining definite settings of the cutter-head. The entire cutter-slide can be operated longitudinally in either direction, and is stopped automatically.

Another feature in connection with the cutter-head that is of particular interest is the fact that, although the head can be swiveled through an arc of 180 degrees, the drive only turns two corners from the source of power. This is a feature which will be particularly appreciated by those who desire a machine having a powerful and accurate drive. The follow-rest shown in place on the machine in Fig. 1 is an independent unit and can be set to the work without loosening the other adjustments of the cutter-head. This follow-rest is designed to carry either a shoe or bushing support for the work and is attached to the cutter-slide, traveling with it.

Miscellaneous Details

The oil-pump for supplying the cutting lubricant to the machine is mounted at the rear of the bed, see Fig. 5, and the oil can only reach the pump reservoir after passing through three separate straining compartments. This prevents any dirt or chips from being forced through the pipe to the cutter.

This type of thread milling machine is built in various sizes, the difference in size being a variation only in the length of the bed. In many cases when cutting fine threads—20 threads per inch—a hob can be used, thus producing accurately threaded work at a rapid rate. On heavier pitches, as previously stated, a single cutter is always used.

Examples of Thread-milled Work

Fig. 4 shows an interesting group of various gears, thread shafts, etc., which have been cut in this machine. The tool-

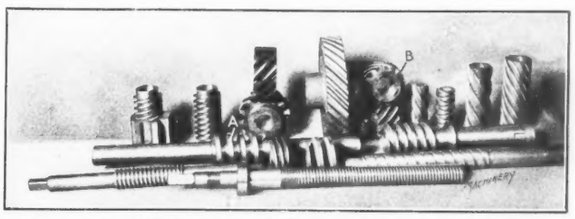


Fig. 4. Interesting Examples of Work produced on the Lees-Bradner Thread Milling Machine

steel worm shown at *A*, which also appears in the machine in Fig. 2, is 1-inch circular pitch, single right-hand thread, and was completed in one cut—being ground after hardening. The spiral gear shown at *B*, and also set up in the machine in Figs. 3 and 5, has 12 teeth, 4-pitch, with a 45-degree helix angle. This gear, which is used on a No. 5 Lees-Bradner gear generator, was completed in one cut. As an illustration of what this thread milling machine will do, the following example is given: A forged-steel worm 6½ inches in diameter, 9½-inch face, 1½-inch circular pitch, 4½-inch lead, 3 threads, was finished complete and accurate in every respect in three

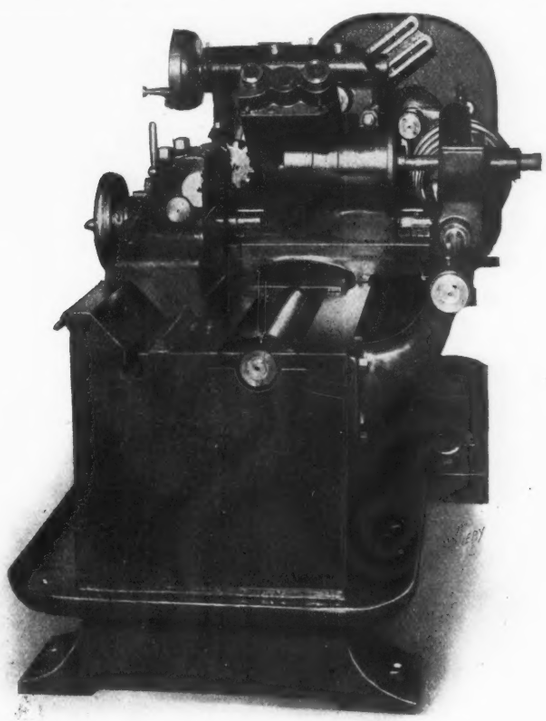


Fig. 5. End View looking toward the Dividing Head. Note Massiveness of Cutter-slide and Liberal Bearing Surfaces

hours. By a close inspection of Fig. 4, many interesting examples will be noted which indicate the wide range of work which this machine is capable of producing.

LEA-COURTENAY COLD METAL SAW

The Lea-Courtenay Co., Inc., 90 West St., New York City, has placed on the market the cold metal saw shown in the accompanying illustrations, Figs. 1, 2 and 3. An important feature of this machine is the arrangement of the swing arm which carries the saw. This arm is pivoted near the center of the frame of the machine and is so arranged that the arc through

which the saw arbor travels is always below the surface of the work on the table. This design does away with the tendency of the saw to dig in and climb on the work, and as a result a material reduction has been made in the number of blades and teeth that are broken. A further advantage of this arrangement of the arm carrying the saw is that it has effected a considerable increase in the cutting range of the machine.

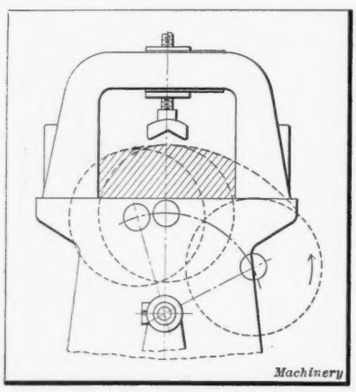


Fig. 1. Diagram showing Arrangement of Swing Arm on Lea-Courtenay Cold Metal Saw

The principle of this design will be readily understood from the diagram, Fig. 1, which shows the movement of the saw arbor and the arc through which it passes; the shaded section shows the available cutting area. These machines are adapted for both belt and motor drive.

Fig. 2 illustrates a machine driven by a variable speed motor which gives a cutting speed at the saw blade of about 35 to 50 feet per minute. The motor is mounted on an extension of the base of the machine and drives the main shaft through a silent chain. Power is taken from this shaft for three purposes: (1) To drive the saw blade; (2) To operate the power feed; and (3) To drive the pump which supplies cutting fluid to the blade. The drive for the blade is taken from the main shaft by means of a steel spur gear and pinion; a tool-steel bevel pinion is attached to the hub of the spur gear and the power taken from this pinion drives through a tool-steel bevel gear, vertical shaft and a second pair of bevel gears to the shaft carrying the sprocket which engages with the holes in the saw blade. A roller chain transmits power from the main shaft to the feed-box, and to guard against accidents through the saw binding, a slip gear is mounted on the shaft leading into the box. A spring presses the fiber frictions together with sufficient force to provide ample power. The tension of this spring can be adjusted by a hand-screw and will allow the feed to slip and protect the machine from being damaged in event of the saw binding. The feed-box provides ten changes which are easily obtained by setting a pull-pin in the desired position. This feed is very similar to the modern feed-boxes on quick change gear lathes. Both of the shafts through this box are made of tool steel. The movement of the swing arm is derived from the segment which meshes with the large worm on the vertical shaft. When the arm is to be fed forward, the tooth clutch at the bottom of this shaft, which will be better seen by referring to Fig. 3, is in engagement with the worm-wheel. When the saw has completed its forward stroke, a pin on the segment engages with an adjustable dog which trips the lower clutch at any predetermined point, and at the same time engages the upper clutch with the spiral gear; this reverses the direction of rotation of the worm and, consequently, returns the saw into position for the next cut. The clutches may be tripped independently of the dogs on the segment by means of the small hand lever shown in Fig. 2. This illustration also shows the vertical handwheel for adjusting the height of the saw blade. The pump for supplying the lubricating fluid to the blade is of the balanced vane positive type which does not require a check valve and will prime itself when the machine is started up. This pump is driven from the second roller chain running from the main shaft.

Partly for convenience in manufacturing and principally to secure perfect castings, the frame of the machine is made in two pieces; the top part is joined to the base at a point slightly above the level of the tank which holds the lubricating fluid, and this design effectually prevents leakage. The two sections are bolted together. The top of the table has three T-slots; the outside ones are used for holding the V-blocks, and the middle one for holding work of irregular shape. The top of the table is also provided with two rows of holes for inserting pins to be used as work-stops. These machines are provided with swivel V-blocks which can be set at right angles to the saw blade for cutting work off square, or can be swiveled to cut off structural material at an angle within the range of the

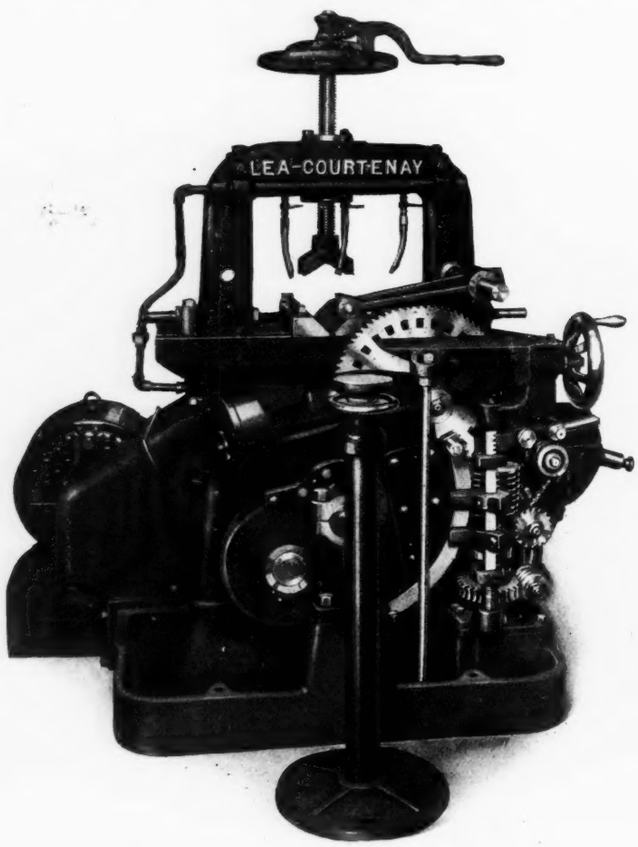


Fig. 2. The Lea-Courtenay Cold Metal Saw, showing Feed Tripping Mechanism

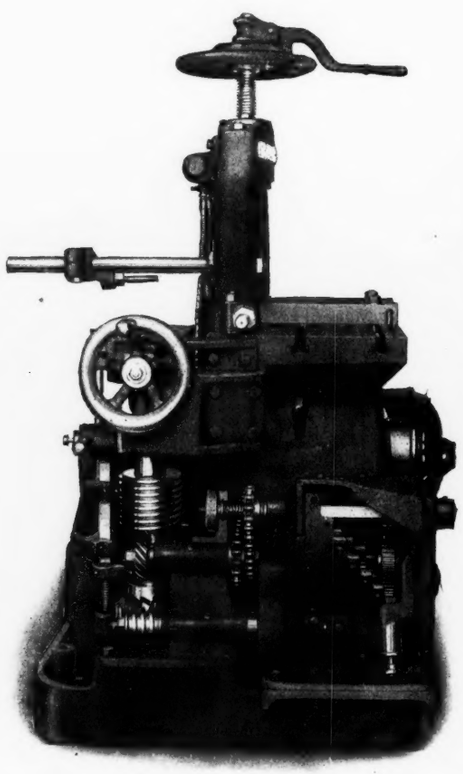


Fig. 3. Front View of Machine, showing Gear-box

machine. In addition to the handwheel on the top of the screw, there is a cast-steel lever with a lug fitted to a spoke of the clamp wheel so that a permanent method of tightening up the work is always at hand. The lower end of the clamp screw is casehardened and fits into the upper V-block, which is a heavy steel casting with two grooves, one of 90 degrees and one of 120 degrees; the latter is used for holding very small work. Particular attention has been given to the selection of the best type of bearings for this machine. Bronze, babbitt, reamed cast-iron and ball bearings are used in different parts of the machine. The swing arm which carries the saw turns on heavy trunnions, one of which is mounted on the center of the frame, the other being supported on the outside by an outboard bearing. Provision has been made for ample lubrication of all bearings, and in three or four cases where the bearings are apt to be neglected a special type of oilless bearings has been provided.

GARVIN TWELVE-INCH CAM CUTTING MACHINE

The illustrations show a cam cutting machine adapted for cutting both face and barrel cams, in sizes ranging from 1 to 12 inches, which has been placed on the market by the Garvin Machine Co., Spring and Varick Sts., New York City. Fig. 1 shows the machine arranged for cutting face cams, and in Fig. 2 it is equipped with the barrel cam cutting attachment. The machine is similar to the standard design which has been developed by this company in its 24- and 36-inch machines. The spindle slide is mounted on balls which run in steel races, making it particularly sensitive. The drive is through a universal joint from the overhead countershaft, and with the belt on the eight-inch step of the cone pulley, the machine runs at 300 R. P. M. The rail slide is counterbalanced and operated by a rotary nut with ball thrust bearings, which gives a quick motion for the removal of the cutter and former pin at the completion of the cam. The spindle slide is clamped in position while making the change and is returned to a positive micrometer stop. The spindle bearings are similar in design to those used on this company's profilers. Provision has been made for instantaneous reversal of the feed or for disengaging the feed entirely. Eight changes of feed are secured by means of the change-gears. The machine can be readily changed from operation as a face cam cutting machine to a barrel cam cutting machine, or *vice versa*, as the fixtures can be readily removed or replaced. A floor space of 32 by 35 inches is occupied by the machine.

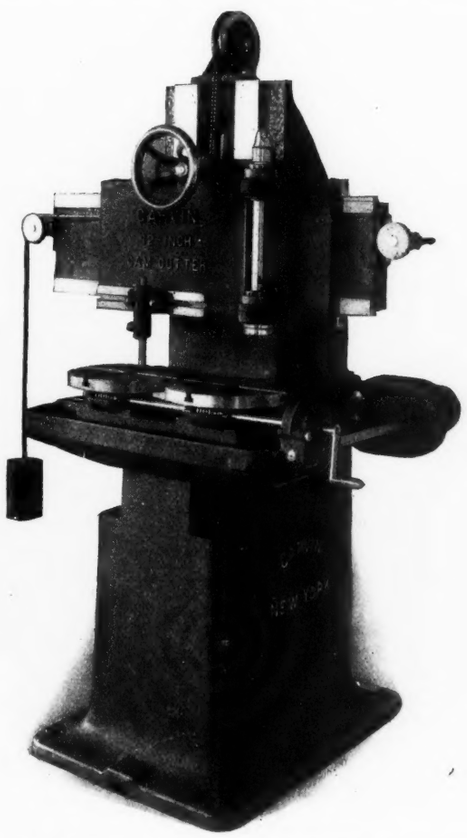


Fig. 1. Garvin Cam Cutting Machine set up for cutting Face Cams

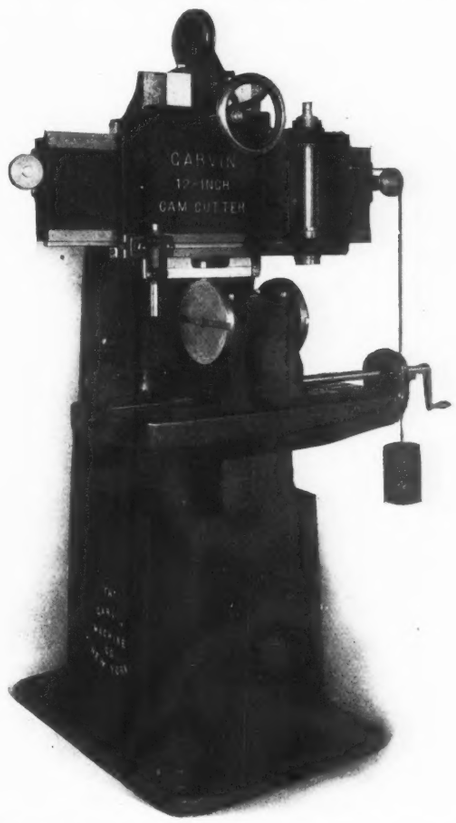


Fig. 2. Garvin Cam Cutting Machine set up for cutting Barrel Cams

BROWN ELECTRIC TACHOMETER

The Brown Instrument Co., and the Keystone Electrical Instrument Co., Philadelphia, Pa., are placing on the market a new electric tachometer to indicate, or record on a chart, the revolutions per minute of a rotating shaft or wheel. There are many operations for which it is desired to have an accurate speed indicator permanently connected to an engine or machine, to show at a glance the speed at which it is running, or to keep a continuous record of this speed on a chart. The electric tachometer has the advantage of being exceedingly accurate, and in addition, the indicating or recording instrument can be located at any desired distance from the shaft, the speed of which is to be measured. The instrument consists of a small magneto or generator, particularly designed for use with this tachometer and which generates 25 volts at 1000 revolutions per minute. The instruments have been designed with unusually high resistance—exceeding 3000 ohms in each instrument—so that the length of leads connecting the magneto or generator and the instrument has no effect on the readings; this also makes it possible for one, two or three instruments to be connected to the same generator without affecting the indications. This high resistance feature is exceedingly advantageous, for frequently after the generator and one indicating instrument have been installed, it is desirable to place a recording instrument at some convenient point, and this second instrument can be connected to the generator without recalibration.

The illustration shows the standard Brown electric tachometer, generator, leads and indicating instrument, as usually supplied. It is often desirable to operate a machine at a certain speed to produce the best results. For instance, in large machine tools where it is desirable to know the cutting speed, the use of this electric tachometer mounted beside the machine

enables the exact speed to be noted at all times and maintained as desired. There are many tests that constantly have to be made for which an electric tachometer of this type will prove particularly advantageous. As an instance, we might cite the use of such instruments on war vessels and merchant ships, where it is particularly desirable to not only indicate the speed of the propeller shaft in the engine room, but also in the chart house and on the bridge. In the case of the U. S.

Brown Electric Tachometer

battleships the small generator is driven by gears, direct from the main propeller shaft, and three indicating instruments are connected to a single generator to indicate the speed at various points about the ship. This is particularly desirable in maneuvering, where a space of say two hundred yards must be maintained between each ship. If a ship in the rear is gaining on the forward one, by signalling for one or two revolutions slower speed, the desired position can be maintained.

SCHUCHARDT & SCHUTTE AUTOMOBILE GEAR HOBBER

The gear hobbing machine illustrated in Fig. 2 has been built by Schuchardt & Schutte, Cedar and West Sts., New York City, to meet the requirements of automobile builders for a machine combining rapid and accurate production of gears from such metals as nickel-chrome and vanadium steel, heat-treated before machining. The machine is not intended for

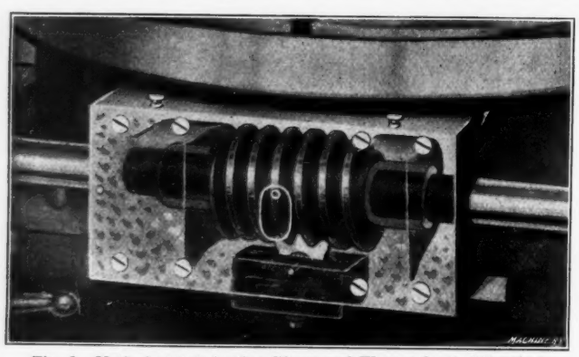


Fig. 1. Method of Lubricating Worm and Worm-wheel of Spacing Mechanism on S. & S. Gear Hobber

handling spiral gear work, and so it is not necessary to set the hob at the angles used in hobbing spiral gears; this has been the means of effecting an important improvement in the design of the machine.

The new machine is designed with the hob below the center about which the cutter head is swung, and by this arrangement it has been made possible to have the hob as close as 5⅜ inches to the face of the upright. This design has served the double purpose of reducing the leverage and enabling the thrust upon the cutter head to be more firmly supported when the hob is being fed across the face of spur gears. The result is seen in a total absence of chatter or vibration when the machine is driving a high-speed steel hob at its full capacity. The weight of the machine has been increased over preceding designs so that its strength has been materially increased; this statement applies particularly in the case of the upright and the cutter head.

The machine is belt-driven by a three-step cone pulley of 3¼-inch face. The back-gears are located in the bed of the machine and there are six available speeds—three direct drive and three through the back-gears. The drive to the cutter is taken from the pulley shaft through a vertical shaft in the upright and two horizontal shafts which transmit power through three pairs of bevel gears and one pair of helical gears. One of the gears in each pair is of phosphor-bronze and the other of steel. The bevel pinion mounted on the pulley shaft also connects with a bevel gear on the shaft which transmits power to the feed mechanism and to the spacing mechanism. The gears for the spacing mechanism are mounted at the end of the bed behind the upright. These gears

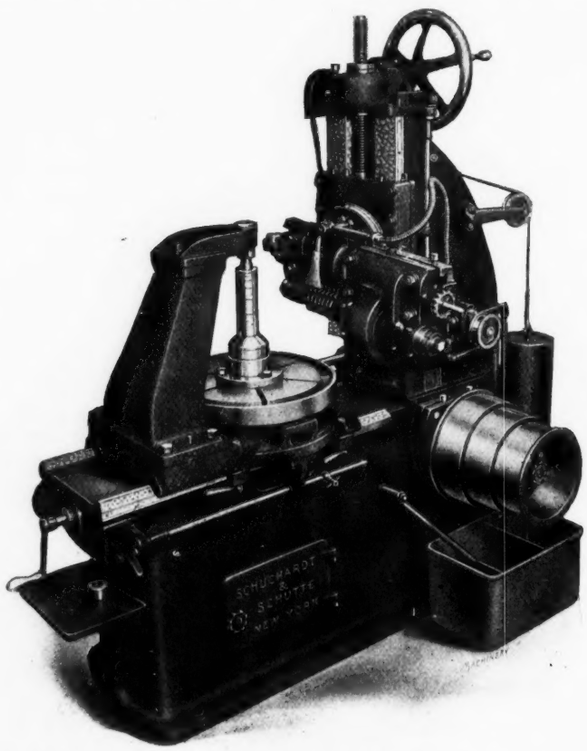


Fig. 2. Schuchardt & Schutte Automobile Gear Hobber for Spur and Worm Gears

transmit power to the spacing shaft, which runs along the side of the bed and drives a worm-wheel on the table by means of a worm on the shaft. Fig. 1 shows the method by which this worm and worm-wheel are lubricated. The small wheel shown in mesh with the worm, dips into an oil reservoir and in rotating, carries up a continuous supply of oil to the worm. A felt wiper is in contact with the worm-wheel at the point where it leaves contact with the worm. This wiper removes superfluous oil and allows it to run back into the reservoir.

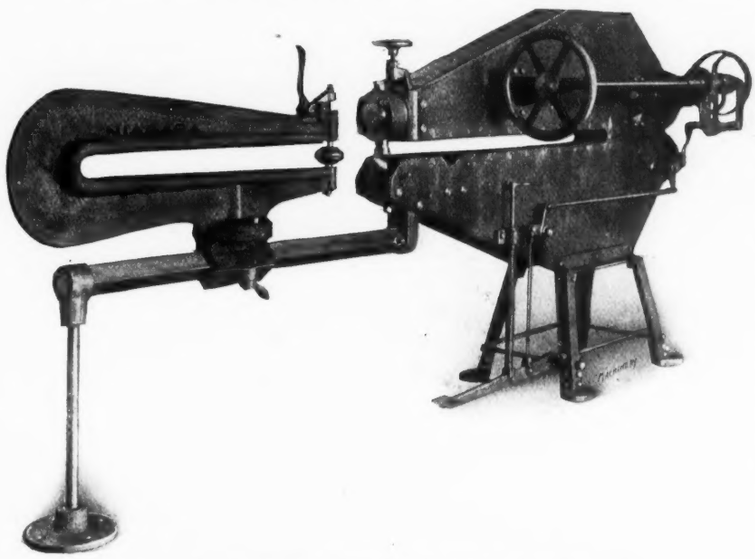
In hobbing worm-wheels, the table is fed in toward the hob by means of the feed-screw in the bed, which is driven from the shaft carrying the sprocket by means of a worm and worm-wheel. In the case of spur gears, the cutter head is fed down by means of a similar drive, the screw being located in the upright in this case. In this connection, it should be mentioned that the drive is secured by rotating a nut on the fixed feed-screw instead of turning the feed-screw in a nut. By means of this design, the nut pushes on the feed-screw and does away with all torsional strains in the screw. The feeds for both worm and spur gears are provided with automatic stops which throw out the drive when the cut is completed.

The table is provided with a rigid arbor support which is

made an integral part of it. The table and oil tray are cast integral so that there is no space for chips to work into the bearing. The table feed-screw is provided with a handwheel for use in setting the table in to the correct position to give the necessary depth of cut in hobbing spur gears. The screw is of 0.200-inch pitch and is provided with a dial reading to 0.001 inch. The feed-screw is 1 7/16 inch in diameter.

NIAGARA ROTARY SHEAR

The rotary shear shown in the accompanying illustration has been added to the line of machines for working sheet metals built by the Niagara Machine & Tool Works, Buffalo, N. Y. This machine is particularly intended for cutting irregular and reverse curves, but it is also suitable for cutting disks and rings, and for slitting metal along straight lines; consequently, it takes care of all classes of work to which rotary shears are applicable. In cutting irregular curves the shapes are scribed on the sheet, which is guided by the operator while being fed through the cutters. As both cutters are driven, the material is self-feeding and very little effort is required to follow the cutting line. The construction of the cutting head is such that the operator's view of the cutting line is unobstructed. The metal leaves the machine cut clean; it is not deformed or distorted and is practically without burrs.



Niagara Rotary Shear for cutting Sheet Metal up to No. 12 Gage

The shears will cut curves and disks down to 1¼ inch radius. If the circle attachment is applied, disks and rings from 3 to 60 inches in diameter can be cut from a square blank. The upper cutter is fastened to the end of a vertical shaft journaled in a turret, which can be swung to the side to permit of removing the cutter for regrinding. The turret, with the shaft and upper cutter, can be raised and lowered by means of a screw and handwheel. The lower cutter is mounted on the end of an inclined shaft. Two pairs of bevel gears connect the cutter shafts with two horizontal shafts, which are driven from the pulley shaft by means of spur gears. A jaw clutch actuated by a foot treadle is provided to enable the operator to start and stop the machine at will. The shear has a variable speed gear drive, providing three different cutting speeds. It can also be operated through a handwheel, which is desirable in cutting difficult shapes, or for sharp corners when it is necessary to reverse the cutters. The cutting head has a throat 60 inches deep, and soft sheet steel up to No. 12 gage can be cut. These shears are built in different sizes for lighter or heavier work.

INGERSOLL MILLING CUTTER GRINDER

The successful operation of any milling cutter depends almost entirely upon the accuracy with which it is ground. There are a number of cutter grinders on the market which will grind small milling cutters satisfactorily, but the grinding of cutters from 10 inches to 36 inches in diameter, accurately and rapidly, was a problem that remained for a large milling machine manufacturer to solve. In addition to the 24-inch patented face milling cutter grinder described in the September, 1911, issue of MACHINERY, the Ingersoll Milling Machine Co. has recently brought out a new grinder with a capacity for cutters up to 36 inches in diameter. This new grinder, which is shown in Fig. 1, will handle cutters as small as 4½ inches in diameter and from ⅛ inch up to 4 inches face. One of the principal features of this grinder lies in its ability to grind the face, the side, and the corner of any milling cutter within its range at one setting of the cutter. The corner of the cutter may be round or angular as desired.

Particular attention has been given to convenience of operation in this new grinder, and it should meet the most exacting requirements. All controlling attachments are placed within easy reach of the operator's working position and all adjustments are graduated to thousandths of an inch. No extra attachments need be added to the machine to grind any face milling cutter within the capacity of the machine. The grinder can be arranged to be driven by either belt or motor as desired. When motor driven, a one horsepower motor is mounted on a base-plate fastened to the base of the grinder. For wet grinding an oil pump is furnished. The design of the grinder has been laid out with particular reference to wet grinding. The sides of the base are brought up sufficiently high so that the cutting fluid used will not be thrown out into the shop. Fig. 2 shows a grinder set in position for grinding

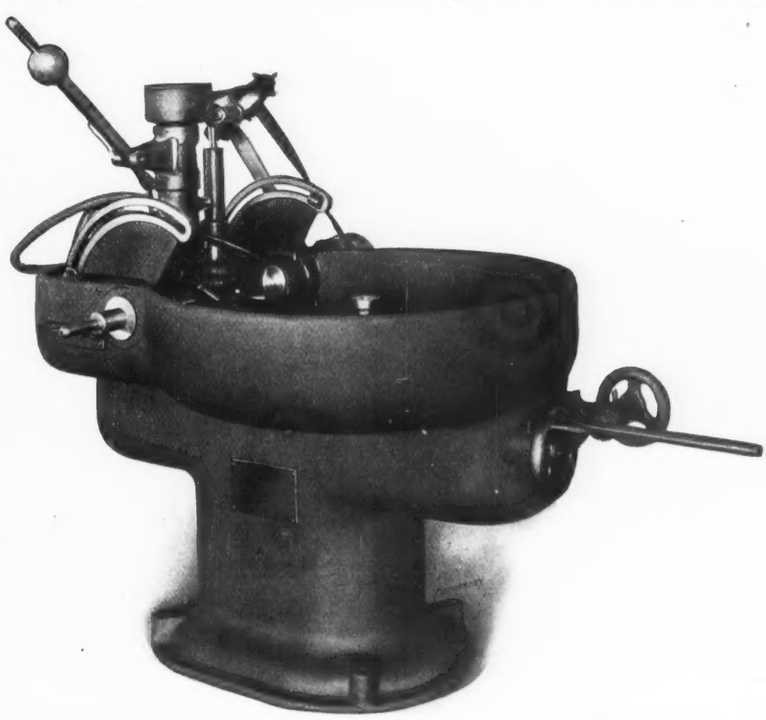


Fig. 1. Ingersoll Milling Cutter Grinder with Capacity for Cutters up to 36 inches in Diameter

a face milling cutter 30½ inches in diameter. The entire cutter is ground complete at one setting. This grinder is fully

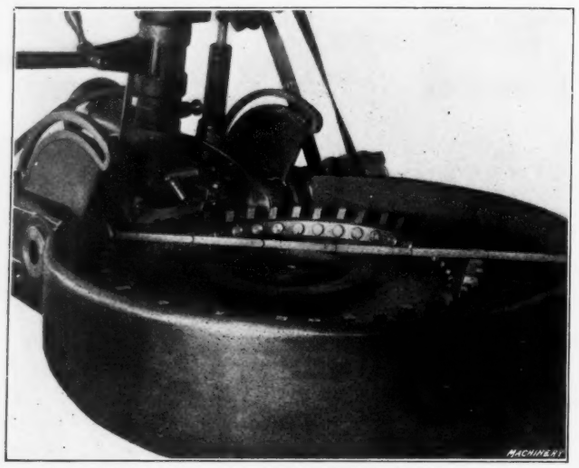


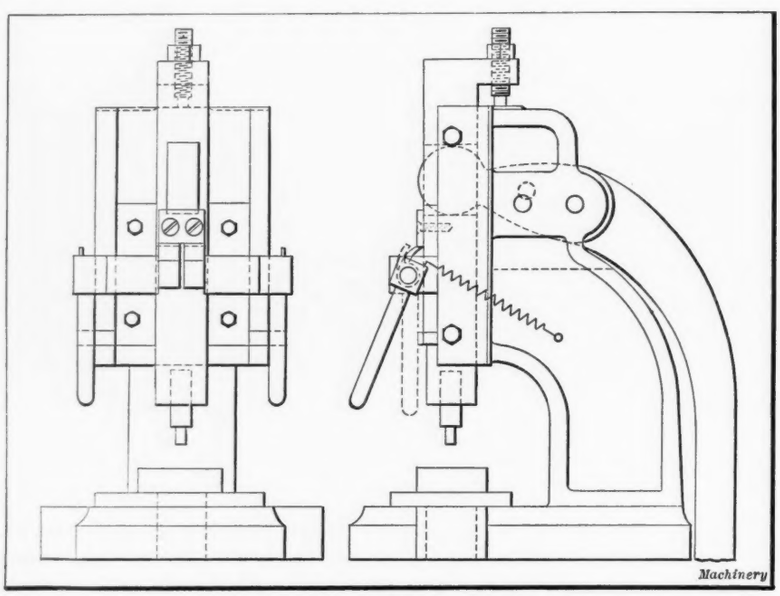
Fig. 2. Machine set up for grinding Face Milling Cutter 30 1-2 inches in Diameter

covered by patents and is manufactured by the Ingersoll Milling Machine Co., Rockford, Ill.

LA SALLE SAFETY DEVICE FOR FOOT PRESSES

The safety device for foot presses shown in the accompanying illustration is a recent product of the La Salle Machine & Tool Co., La Salle, Ill. The use of this device on a foot press makes it practically impossible for the operator to be injured through getting his hands or fingers caught under the slide.

The slide is locked through the medium of two latches, and in order to release it, it is necessary for the operator to use both hands. To do this he pushes forward the two small handlevers at each side of the head of the press. These levers swing on spindles which are journaled in castings bolted to the press, and carry the latches which lock the slide. When it is desired to trip the press, both of these levers are pushed forward to disengage the latches from the steel block screwed to the slide. The machine can then be tripped in the regular

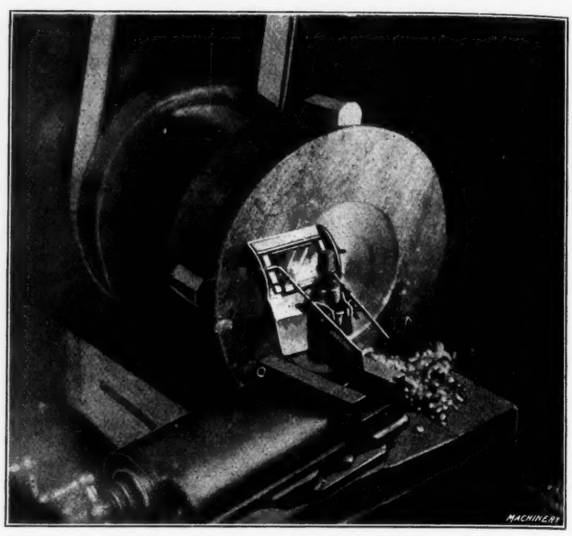


Foot Press Safety Device released by Two Hand Levers

way, and upon the return of the slide to its highest position, the latches are brought back into engagement with the steel plate on the slide by the tension of two springs. The construction is both simple and efficient and its details will be readily understood by referring to the accompanying line engraving.

BARCY-NICHOLSON LATHE CHIP GUARD

The universal chip guard shown herewith was made for use in the plant of the American Steel & Wire Co. by the Barcy-Nicholson Co., Detroit, Mich., to prevent injury to operators from flying chips. This guard is especially designed for use on the heavier classes of lathe work, and has been found to give satisfaction in this service. The guard is 4 inches wide by 5½ inches high, and has a heavy glass window 2 inches



Chip Guard especially adapted for the Heavier Classes of Lathe Work

high by 2½ inches wide which is slipped in from the top and held in place by a 3-16-inch rod. The frame of the guard is 3-32 inch thick, and has a slit ⅞ inch by 1½ inch, which allows the guard to slip over the tool-holder and drop down flush with the toolpost ring; the guard is held to the toolpost with a clamp and two rods. The clamp is adjustable to fit different sized toolposts and the guard may be adjusted for different classes of work.

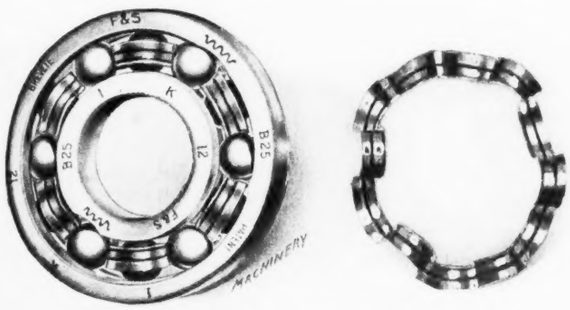
F. & S. RIBBON TYPE BALL SEPARATOR

The illustration shows a new form of ball separator which is being generally used in the F. & S. ball bearings where the die-cast aluminum separator was formerly applied. The new separator is known as the ribbon type and is formed from a single steel stamping drawn and formed without joints, welds or rivets in its construction. The separator is heavily ribbed on one side to give added stiffness, and is finished in gun-metal blue. It is light in weight and causes practically no friction. The new separator permits raceways with deeper grooves to be used than is possible with other types of separators, and this adds considerably to the lateral wall strength of the inner and outer race-ways.

The illustration shows the construction of the separator and also an assembled bearing in which the separator can be seen. Several advantages are claimed, among which the following may be mentioned: It permits the bearing to be operated at high speed, and it is not affected by ordinary vibrations. Larger balls may be used, and in many sizes of bearings a larger number of balls can also be used. This statement, however, does not apply to all sizes of bearings, since the ribbon type of separator requires the use of an even number of balls, and consequently, in sizes where an odd number of balls was formerly used, it is necessary to reduce the number by one instead of increasing it. But as the load capacity of a bearing varies as the square of the ball diameter and as the first power of the number of balls, a slight increase in diameter of the balls compensates for decreasing their number by one,

and in many sizes of bearings the load-carrying capacity has been increased thirty per cent.

Another advantage of the ribbon type of separator is that it permits a freer circulation of lubricant and also lessens the probability of foreign particles being retained in the separator.



F. & S. Ribbon Type of Ball Separator

Although this separator has been but recently placed on the market, it has been subjected to careful tests during the period of about a year; it is stated that bearings equipped with it run even more smoothly and quietly than those in which the aluminum type of separator is used. The J. S. Bretz Co., 250 W. 54th St., New York City, is agent for the F. & S. ball bearing in America.

GARDNER GRINDING AND POLISHING MACHINES WITH BALL BEARINGS

That ball bearings can be used advantageously in disk grinding and polishing machines has been proved by the Gardner Machine Co., Beloit, Wis. This company has recently equipped a number of its grinding and polishing machines with ball bearings, and tests which have been made with the view of comparing the efficiency of ball bearings and plain bearings in this class of service show that with ball bearings considerably less power is required to operate the machine. This

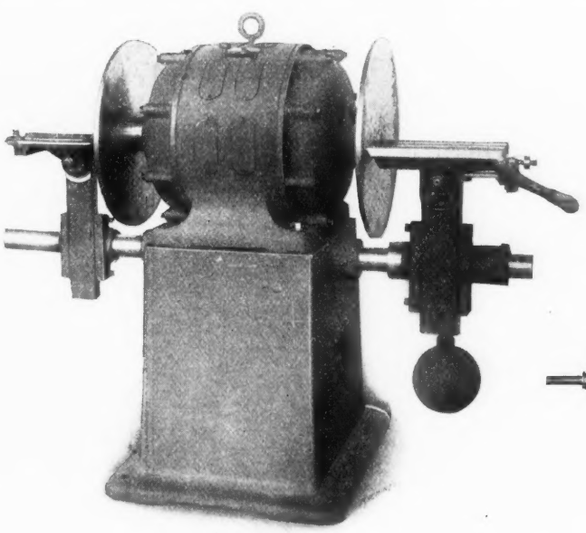


Fig. 1. No. 4 Gardner Disk Grinder equipped with Fully Enclosed Motor and Ball Bearings

saving of power is particularly noticeable in the motor-driven machines and in all types of polishing machines.

Fig. 1 shows a No. 4 Gardner disk grinder equipped with a fully enclosed 5-horsepower alternating-current motor. The motor is equipped with special end yokes and radial and thrust ball bearings. It will be noticed that the machine shown in the illustration has a universal lever feed table for the right-hand disk and a plain table with a squaring gage for the left-hand disk; the wheels used on this machine are 23 inches in diameter. Fig. 2 shows a No. 18 Gardner patternmaker's disk grinder fitted with radial and thrust ball bearings. This machine is equipped with two disk wheels, 30 inches in diameter, which are faced with special garnet paper. Fig. 3 shows the bench type of polishing lathe equipped with ball bearings. It will be noticed that this machine is arranged for under-belt drive. Other features of the Gardner polishing lathes are the ample dimensions of the spindles and the rigid construction of the machine. This polishing machine is also built in the floor type, and both the floor and bench types are made in four different sizes.

Ball bearing countershafts are also being furnished by this company for use in connection with any of the machines, and practically all of the disk grinders can be equipped with ball bearing motor drives. It may be of interest to state that after the power has been shut off from a ball-bearing disk grinder, the spindle and disk wheels will continue to revolve for eight

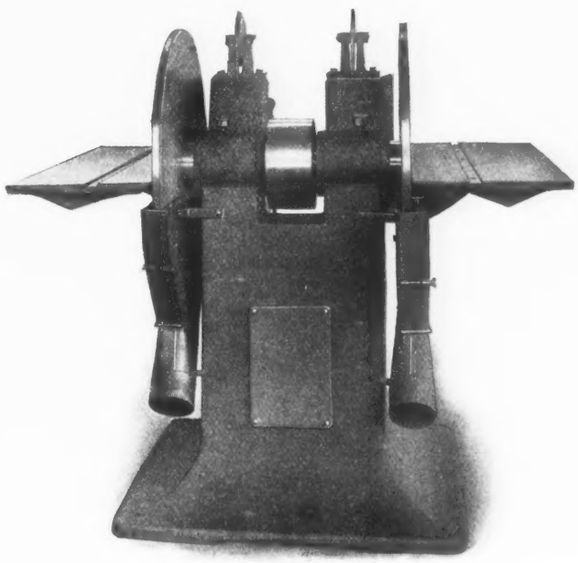


Fig. 2. No. 18 Gardner Patternmaker's Disk Grinder equipped with Ball Bearings

or ten minutes. In actual practice, this momentum of the wheel is naturally overcome by the reaction between the work and the face of the wheel, but the ability of an idle wheel to run for such a length of time shows the efficiency of ball bearings in this class of service.

BRAMWELL PRECISION DRAWING INSTRUMENT

The precision drawing instrument shown in the accompanying illustrations was recently placed on the market by Joseph

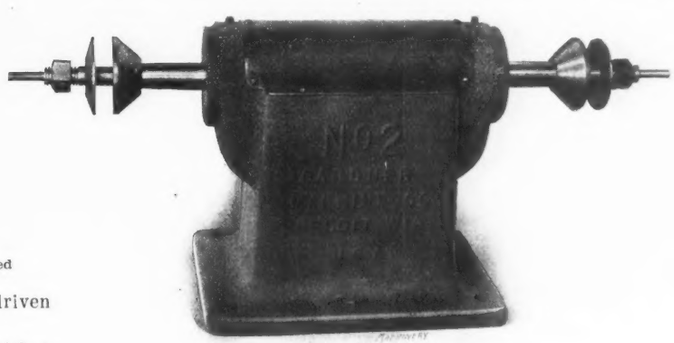


Fig. 3. Bench Type of Polishing Lathe equipped with Ball Bearings

W. Bramwell, 4931 Rubicam Ave., Philadelphia, Pa. This instrument embodies features conducive to the production of accurate and rapid work, and provides for drawing horizontal and vertical lines, and inclined lines at any angle; provision is also made for accurate section lining. Means have also been provided for locking the instrument so that both of the operator's hands are left free. The blade extends right across

the board so that practically the entire surface may be used; in addition to the angular settings provided by the scale on the carriage, the blade can be set at any angle with the edge of the board, which is a useful adjustment when perspective drawings are being made.

Referring to Fig. 1, it will be seen that the instrument comprises a carriage *A* which runs on a straight steel bar *B*, attached to the left-hand end of the drawing-board. This carriage is provided with a clutch which receives the male portion of the clutch attached to the blade; this clutch provides for locking the carriage in any required position. The blade and carriage constitute a unit which travels along the bar and somewhat resembles the ordinary swivel T-square, except that the carriage is automatically held to the bar, leaving the operator's hands free. The bar can be adjusted for height by means of the thumb-screws shown at *C* and moved parallel to the end of the board. The blade *D* has a metal strip *E* fixed to its face which forms a track for the scale carriage to run on from end to end of the blade. The scale carriage *F* is held automatically in any position upon this track in the same manner as the carriage which carries the blade. The scale carriage is arranged with holes for locking the scale at the common angles 30, 45, 60 and 90 degrees, and the scale can easily be set for special angles that are required in drawing the heads of screws, etc. Where such angles are commonly used, it is an easy matter to drill special holes in the carriage for locking the scale for drawing them. A finely graduated arc is also provided, which, in conjunction with a detachable vernier arm *G*, enables angles to be drawn to an accuracy of three minutes. The scale *H* revolves on a pivot and the arm carrying the locking-pin extends out at the opposite side of this pivot in the manner shown; this arm and pin provide a means for locking the scale securely at the required angle. It will be seen that the scale can be swung to any angle between th vertical and horizontal positions. An auxiliary scale *I* is also provided for horizontal work so that the time required to swing the scale *H* down is saved in most cases where horizontal lines are being drawn.

The attachment for section lining is shown at *J*. This attachment consists of a screw carried by a support clamped to the scale carriage track *E*, and a nut secured to the scale carriage. When the knurled knob at the end of the screw is turned, it advances the carriage, and a ratchet and pawl provide means for spacing so that the section lines are accurately located. This attachment can be mounted in position for section lining or removed from the instrument in a few moments. A device on the arm supporting the scale makes the latter suitable for use on both ink and pencil work, and as the attachment is securely held, the operator has both hands free for holding his pen and manipulating the section liner.

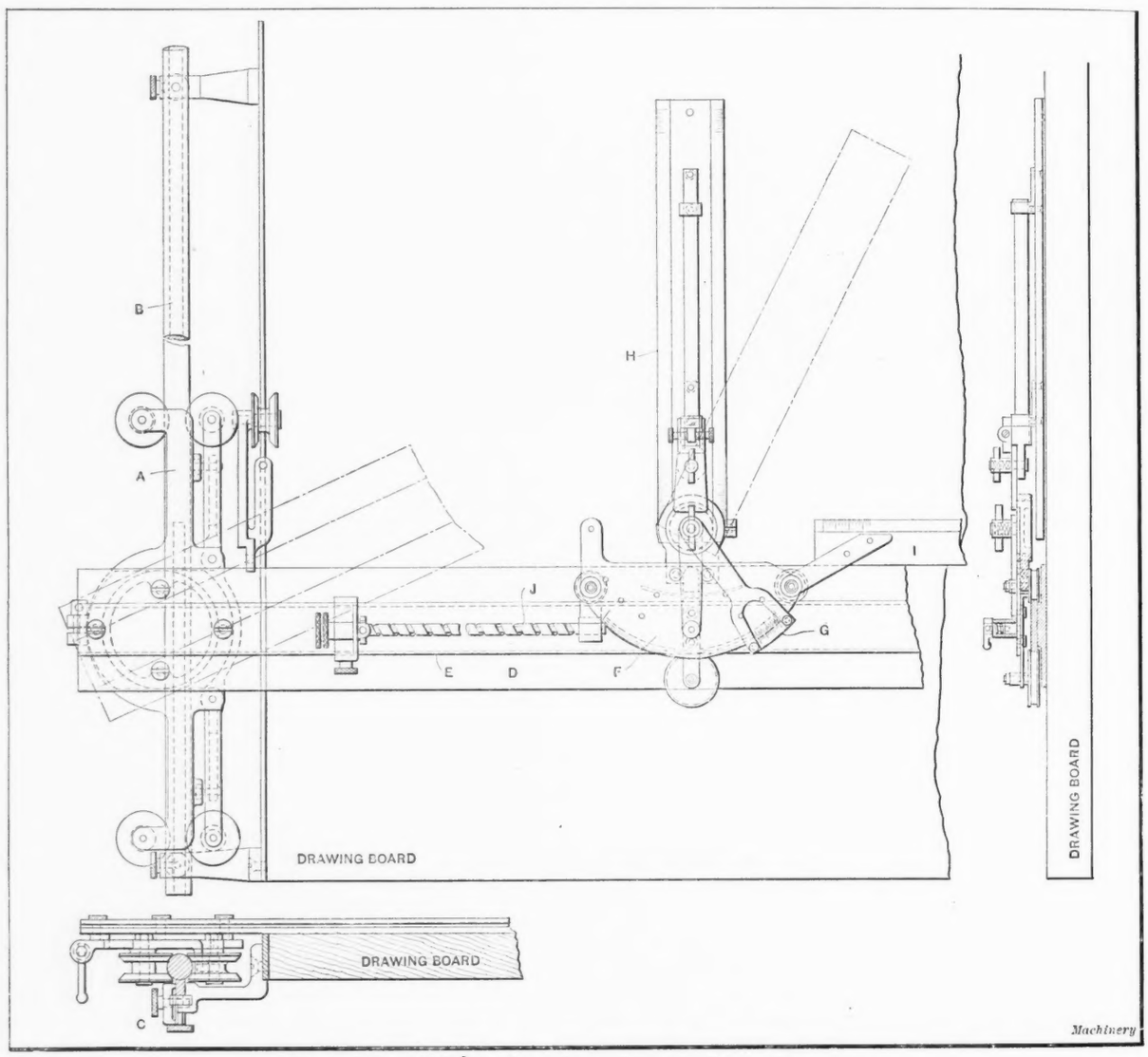


Fig. 1. Design and Construction of Bramwell Precision Drawing Instrument

This instrument is at present being made in sizes suitable for moderate sized drawings, but it is intended to increase its scope to the field of the large drawings used in civil and mining engineering work. These instruments will be arranged for attachment to the edge of the drafting table used in engineers' offices.

NEW MACHINERY AND TOOLS NOTES

Inclinable Foot Press: Rockford Iron Works, Rockford, Ill. An inclinable open-back, foot press which is made in several different sizes.

Shaft Centering Machine: Rockford Drilling Machine Co., Rockford, Ill. A shaft centering machine which can also be used for rounding ends of cold-rolled shafting.

Vertical Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. Vertical milling machine similar to the established design of this company, but comprising a number of improvements.

Helical Gear Cutter: Gleason Works, Rochester, N. Y. A helical gear cutter of the planer type for planing double helical gears of coarse pitch. The machine is particularly adapted for cutting helical mill pinions.

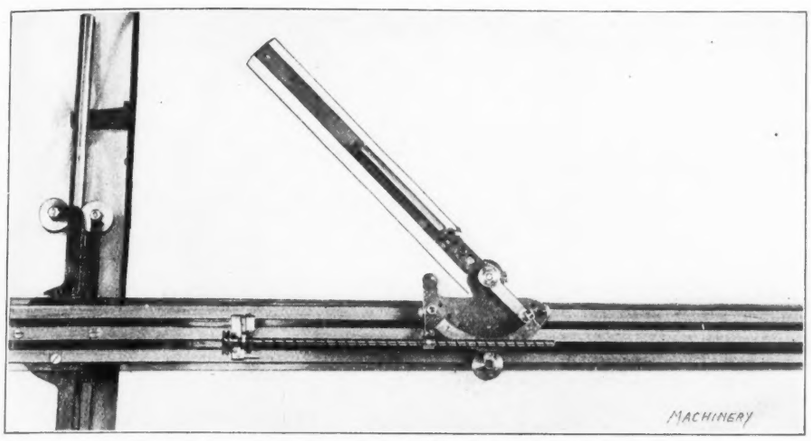


Fig. 2. Bramwell Drawing Instrument with Section Lining Attachment in Use

Portable Shear: Danville Foundry & Machine Co., Danville, Pa. A portable shear similar in design to the machine formerly manufactured by this company but modified to reduce the high fulcrum formerly used.

Lathe for Turning Projectiles: Niles-Bement-Pond Co., 111 Broadway, New York City. A special lathe for turning projectiles, having a wide speed range and high spindle speed, which is necessary when finishing the points of projectiles.

Adjustable Spring Tool-holder: Imperial Tools Mfg. Co., Brooklyn, N. Y. An adjustable spring or goose-neck tool which is so designed that it may be swung around to finish fillets and similar work without changing the toolpost setting.

Marking Machine: Hjorth Lathe & Tool Co., Boston, Mass. This machine is designed to mark straight and flat work in metal with imprints of trademarks, patent dates or other designations. It has a capacity for sizes up to 3½ by 10½ inches.

Buffing and Polishing Machine: Webster & Perks Tool Co., Springfield, Ohio. The machine is equipped with S. K. F. double-row, self-aligning ball bearings; it has tight and loose pulleys on the spindle and may be belted from either above or below.

Lincoln Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. A new machine known as the No. 7H Lincoln miller, which has an over-arm and auxiliary arbor support to provide for increased rigidity, and an adjustable tailstock of special design.

Portable Electric Drill: Standard Electric Tool Co., Cincinnati, Ohio. This drill is made in four sizes having capacities for drills of 1/4, 5/16, 1/2 and 3/4 inch diameter. The motor is so designed that the drill can be connected to a lamp socket on either alternating or direct current.

Multiple-spindle Drilling Machine: Henry & Wright Mfg. Co., Hartford, Conn. This machine is made with from one to eight spindles, with 16 inches between centers. The design comprises a number of valuable improvements which add to the efficiency of the machine.

Emery Wheel Guard: Challenge Machine Co., Inc., Philadelphia, Pa. A floor type of emery wheel guard made of steel channel stock. The guard has adjustment both vertically and horizontally and is equipped with a leather brush which serves the purpose of an eye guard.

Multiple-spindle Drilling Head: W. E. Scallan & Co., Cincinnati, Ohio. This multiple-spindle drilling head consists of a driving shaft and housing with brackets which carry the auxiliary drill spindles. The spindles can be set to drill at any point between two circles of 4¼ and 11 inches in diameter. The closest center distance between spindles is 2 inches.

Geared Pump: Matson Machine & Tool Co., Bethel, Vt. A geared pump adapted for pumping oil or water to cutting tools of automatic and other machinery. The pump has a relief valve which regulates the pressure on the feed pipes and nozzles. The overflow from the relief valve returns to the tank.

Hacksaw: North Wales Machine Co., North Wales, Pa. Hacksaw machine equipped with gravity feed, automatic speeds and a swivel vise provided for cutting angles to 45 degrees. The machine operates at from 70 to 90 strokes per minute and will cut through a 1½-inch steel bar in two minutes.

Quartz Lamp: Cooper-Hewitt Electric Co., 165 Broadway, New York City. Lamp in which provision has been made for a vapor pressure of nearly one atmosphere. This increased vapor pressure means a corresponding increase in the luminosity of the vapor, with corresponding improvement in the efficiency of the lamp.

Sixteen-inch Engine Lathe: Cincinnati Iron & Steel Co., Cincinnati, Ohio. A new 16-inch engine lathe, which is characterized by the strength and simplicity of its design. Only two levers are required in making all changes in feeds and threads and these changes are made without the necessity of changing the gears.

Locomotive Link Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A machine for milling locomotive links, which consists of this company's No. 2 vertical milling machine, in which the lower cutter arbor support is hinged on one side of the machine to permit swinging it out of the way when not in use.

Hydro-pneumatic Accumulator: Watson-Stillman Co., 192 Fulton St., New York City. A hydro-pneumatic accumulator designed for equalizing the demand made by hydraulic presses when operating in severe service. The claim is made that this accumulator operates without shock, occupies little space and works with great regularity.

Combination Dry and Wet Grinder: Springfield Mfg. Co., Bridgeport, Conn. The wheel at the right-hand end of the spindle of this machine is equipped with a pump, tank, drain pan and special hood to adapt this wheel for wet grinding. The wheel at the left-hand end of the spindle is used for dry grinding and is arranged in accordance with the established design of this company.

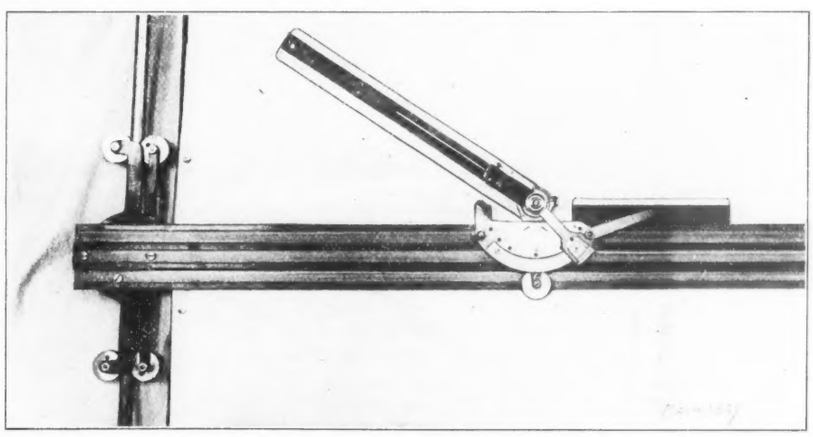


Fig. 3. The Instrument arranged with Auxiliary Horizontal Scale and Vernier Angle Gage

Shaft Straightening Machine: Rockford Drilling Machine Co., Rockford, Ill. A shaft straightening machine designed for handling shafting up to 2¼ inches in diameter by 8 feet in length. The headstock spindle runs at a slow speed, while the machine is in use, and carries a center and a spring chuck with a leather friction face for rotating the shafting when it is picked up between the centers.

Cylindrical Grinder: Queen City Machine Tool Co., Cincinnati, Ohio. A line of plain cylindrical grinders which are built in two swings of 10 and 12 inches and in lengths of 36, 48, 60 and 72 inches for each swing. The design provides for

a stationary work-table and a traversing wheel base. Massive construction and simplicity of design may be said to constitute the characteristic features of the machine.

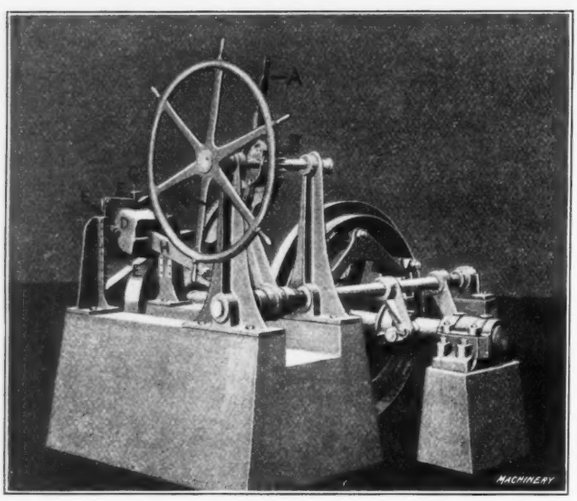
Frog and Switch Planer: Woodward & Powell Planer Co., Worcester, Mass. Two types of frog and switch planer for motor and belt drive, respectively. With the belt drive, the housings are carried up to the full dimensions of a 36- by 36-inch machine to provide sufficient belt length. With the motor drive, the housings are low with only sufficient height above the table to provide for the 17 inches required under the cross-rail.

Vertical Turret Lathe: Bullard Machine Tool Co., Bridgeport, Conn. A 36-inch vertical turret lathe, similar in design to the preceding types of machines built by this company, but comprising a number of important improvements. All of the driving and feed gears are of alloy steel. Lubrication is provided from a continuous flow system. The interlocking machine control is centralized. A rigid support is provided for the cutting tools and work-table.

* * *

DODGE SAFETY DEVICE FOR RUBBER GRINDING MACHINE

In the process of preparing crude rubber for commercial purposes, large rolls are used for grinding and mixing operations. The material is fed to these rolls by hand with more or less danger to the employe. Trouble had been experienced by the Mishawaka Woolen Mfg. Co. from injuries sustained by its employes while operating these machines. With the view of avoiding such difficulties, the problem of developing a safeguard was turned over to the Dodge Mfg. Co., Mishawaka, Ind., and the device finally hit upon is shown in the accompanying illustration. The lineshaft from which power is taken to drive the machine was equipped with a 60-inch iron-center,



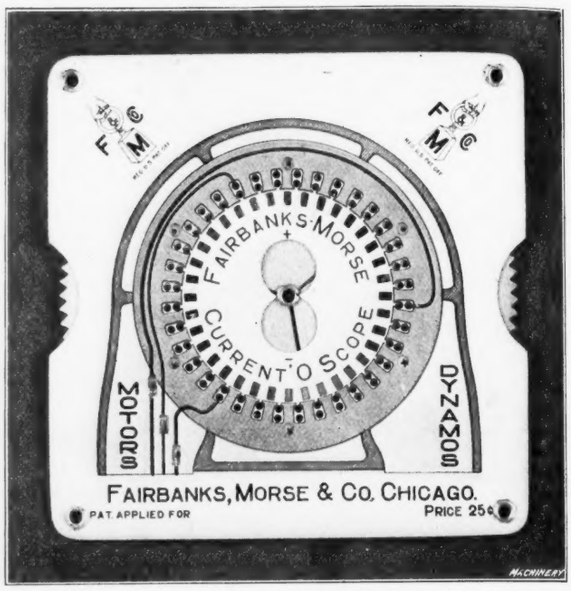
Safety Device used on Rubber Grinding Machine

wood-rim pulley and a Dodge split clutch. This clutch is engaged by the handwheel which turns the pinion *B* and segment gear *C*, which, in turn, engages the clutch. The lever *A* disconnects the wheel from the mechanism by sliding pinion *B* out of mesh with the segment. It is evident that such a method is too slow to enable the machine to be stopped in time if an operator gets caught. To avoid this difficulty, a cord is attached to the loop *G;* this cord runs over two pulleys which brings its other end back to the operating position in front of the machine. The operator has his foot in a loop in the end of the cord, and by pulling it he is able to disengage the clutch instantly. The method by which the device operates is as follows: When the loop is pulled the lever *F* disengages the hook lever *E* from weight *D*. This allows the weight to fall and bring the lever *H* into contact with a dog which throws the clutch out of engagement. This safety device has been so successful in the works of the Mishawaka Woolen Mfg. Co. that it has recently been adopted by the Rubber Regenerating Co. of the same city.

FAIRBANKS-MORSE CURRENT-O-SCOPE

The Fairbanks-Morse "Current-O-Scope," shown herewith, is a simple device for illustrating the principles of the revolving magnetic field in three-phase bi-polar induction motors. It shows the direction of the phase currents and the location of the magnetic fields, the relation of the instantaneous current values and how the phases combine in the windings to produce the revolving field.

The "Current-O-Scope" is made of two sheets of celluloid,



Fairbanks-Morse Current-o-scope for determining Instantaneous Current Values in a Three-phase Circuit

the motor diagram being laid out on the face of the front sheet. A notched disk, which may be rotated with the fingers, is mounted on a central pivot between the two sheets of celluloid, and has the vector diagram laid out on it. This device, which affords simple and effective means of explaining the principles of the revolving magnetic field in induction motors, is being distributed by Fairbanks, Morse & Co., Wabash Ave. & Eldredge Pl., Chicago, Ill.

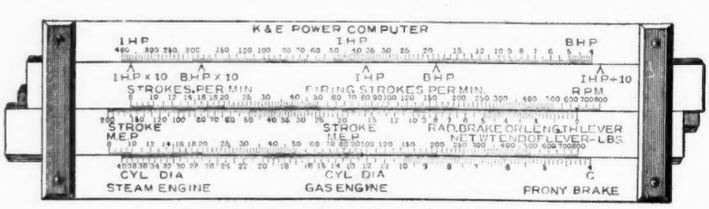
* * *

KEUFFEL & ESSER POWER COMPUTING SLIDE-RULE

The Keuffel & Esser Co., Adams and 3d Sts., Hoboken, N. J., has placed upon the market a slide-rule especially laid out for making power computations from the fundamental power formula:

$$\text{H. P.} = \frac{PLAN}{33{,}000}$$

This rule is applicable for making calculations on all types of reciprocating engines, whether driven by steam, gas or oil. In addition to its use in making power calculations, it can be applied in determining dimensions, etc., of engines where the power developed is known. There are five series of graduations which are used for determining the brake horsepower,



Keuffel & Esser Power Computing Slide-rule

indicated horsepower and also the principal dimensions of steam, gas or oil engines.

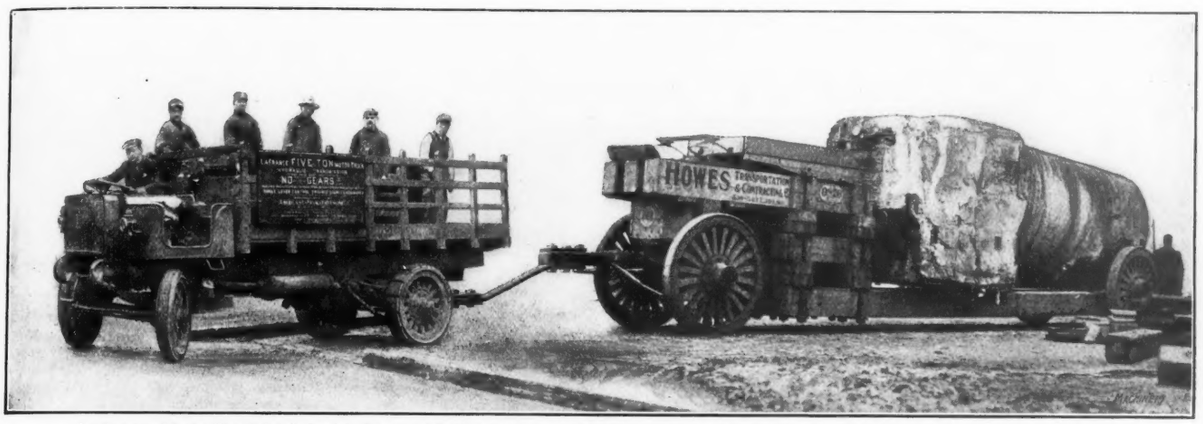
The frame of the rule is made of mahogany, faced with white celluloid on which the graduations are printed. It is designed with the regular K. & E. adjustment for the slide

so that the latter can be regulated for expansion and contraction due to atmospheric conditions. The reverse side of the rule is laid out with the regular logarithmic scales used on the Mannheim slide-rules so that it can be used for ordinary calculations, in addition to the power computations made with the scales on the opposite side.

* * *

HAULING A FORTY-FIVE-TON LOAD WITH A MOTOR TRUCK

A load of forty-five tons was recently hauled by a La France hydraulic truck from the Municipal Bldg. to 67th St. and the East River, New York City, going up Broadway to 59th St. The truck itself, weighing 4½ tons, was loaded with 6 tons of boiler fittings; and a wagon weighing 12½ tons and carrying a boiler weighing 22 tons was attached behind it. At least twenty horses would have been required to haul this load. These twenty horses would have occupied at least 250 feet on the streets of the city and would have effectively blocked all traffic while they were passing. The truck is only 20 feet long, so that there was over 230 feet of street space saved. Furthermore, the run was made with the truck in half the time that horses would have taken and that means that the streets were in use only half as long. The hydraulic transmission gear of the La France truck made it possible to start and stop with such a heavy load without straining any part of the truck mechanism.



La France Motor Truck loaded with 6 tons of Boiler Fittings, and pulling a 12 1-2 ton Wagon loaded with a Boiler weighing 22 Tons

* * *

THE NATIONAL AUTOMOBILE SHOW

The growth of the automobile and motor truck industries in America is reflected in the annual shows held in New York and other large cities, which have become larger and larger each year. The National Automobile Show, which was held in New York in January, occupied two large buildings, Madison Square Garden and the Grand Central Palace. The show was divided into two parts. Part 1 was exclusively for pleasure vehicles, motorcycles, accessories, supplies, etc., and Part II for motor trucks, commercial vehicles, machine tools accessories, supplies, etc.

The growth in favor of motor vehicles for commercial purposes was indicated by the large representation at the Part II show. Over seventy makes, ranging from the lightest delivery wagons to ten-ton trucks, suitable for almost every line of business, were on exhibition. Among the novelties were tractors for converting horse-drawn trucks into motor trucks. An advantage of the tractor is that its weight is well within six tons which is considered to be the limit for solid rubber tired trucks, whereas the trailer may have steel tires.

A machine tool exhibit is a new feature of the automobile show, and the first showing did not adequately represent this important industry. The decision to invite machine tool builders to exhibit machine tools used largely in the manufacture of motor vehicles, was made by the show management too late to permit many of the builders to make a creditable exhibit ready. It is hoped by the management that next year the machine tool exhibit will be one of the big attractive features.

The machine tools were shown in the basement of Madison Square Garden, although the first published announcement stated that it would be made in Grand Central Palace. The following concerns were represented: Baush Machine Tool Co., Springfield, Mass.; Bullard Machine Tool Co., Bridgeport, Conn.; Eveland Engineering & Mfg. Co., Philadelphia, Pa.; Fox Machine Co., Grand Rapids, Mich.; Fairbanks Co., New York; Garvin Machine Co., New York; Hisey-Wolf Co., Cincinnati, Ohio; Lees-Bradner Co., Cleveland, Ohio; Potter & Johnston Machine Co., Pawtucket, R. I.; Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

* * *

AMERICAN MUSEUM OF SAFETY AWARD

The annual exercises and award of four gold medals of the American Museum of Safety, were held in the United Engineering Societies building, New York, January 23. The *Scientific American* medal, which is awarded to the most efficient safety device invented during the last three years, was given to the Draeger Oxygen Apparatus Co. for the pulmotor, an apparatus for inducing respiration in cases of drowning, asphyxiation, etc. The Travelers' Insurance Co.'s medal, which is awarded to the American employer who has accomplished the most for tne protection of the lives and limbs of the workman, was awarded to the New York Edison Co. The Louis Livingston Seaman medal, which is awarded for progress and achievement in the promotion of hygiene and sanitation and the mitigation of occupational diseases, was given to the National Cash Register Co. The Rathenau gold medal, which was placed at the disposal of the museum by the Allgemeine Elektricitäts Gesellschaft of Berlin, Germany, to be awarded for the best device or process in the electrical industry for safeguarding industrial life and health, was given to Thomas A. Edison.

Arthur Williams, president of the museum, delivered an address in which he reviewed the progress made in promoting safety of life and limb in our industrial undertakings. He mentioned the fact that as regards museums of safety, America makes a poor showing compared with foreign countries. There are twenty-two museums of safety in the world, and only one in the United States. The museum is in great need of larger quarters, many models and specimens having never been unpacked because of lack of room to show them. Andrew Carnegie spoke, following Mr. Williams, and expressed great interest in the museum's work and amazement at what had already been accomplished. Other speakers of the evening were T. C. Martin, Dr. George F. Kunz, Dr. Norman E. Ditman, A. A. Anderson and Dr. F. R. Hutton. Dr. Hutton presented the medals to representatives of the recipients.

Announcement was made of a fifth gold medal which had been placed at the disposal of the museum by Mrs. Mary W. Harriman, widow of the late E. H. Harriman. The medal will be known as the E. H. Harriman memorial medal, and will be given each year to the American steam railway making the best record in accident prevention and industrial hygiene.

Dr. W. H. Tolman showed a series of lantern slides illustrating museums of safety, guards for dangerous machinery, the conditions of dangerous industries, etc.

AUTOMATIC PROFILING DEVICE

An automatic feeding mechanism applicable to profiling and other machines in which the cutter must describe an irregular path, has been patented by C. R. North of Hartford, Conn. By means of this mechanism a profiling machine may be made

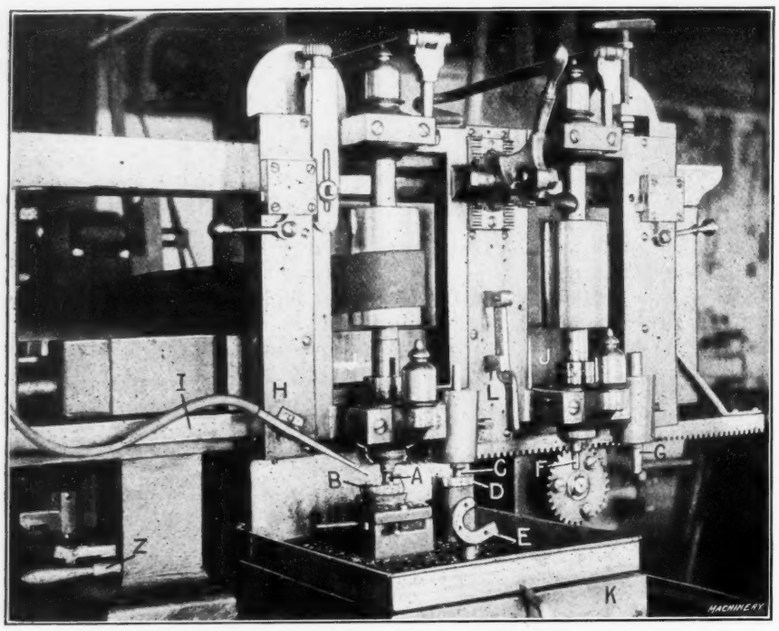


Fig. 1. Profiling Machine with Automatic Feeding Device

semi-automatic in its operation, the only attention necessary being the locating and removing of the work. Profiling machines, generally speaking, are provided with a cutter spindle

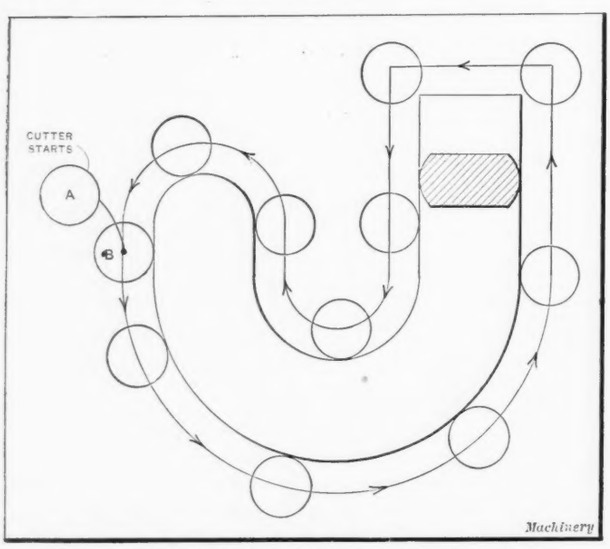


Fig. 2. A Typical Job of Profiling showing Path automatically traversed by Cutter

and a former pin located at a fixed distance from each other at the head of the machine. The former pin is guided around a steel master plate by hand, feeding the head of the machine in a lateral direction and the work-table in a longitudinal direction. On hand profiling machines the operator's attention is required all of the time. By employing this automatic feeding device one man can run two or more machines, depending upon the speed with which the cutter is fed.

The automatic feeding is accomplished by means of two cams at the rear of the machine, one of which operates the transverse movement of the cutter and cutter-slide, while the other cam moves the work-table in a longitudinal direction. By a combination of these cam movements any desired curve or outline may be readily followed. For the purpose of demonstration, the piece shown in Fig. 2 was selected as the outline to be automatically profiled. The reason for selecting this particular shape was that it incorporates a large outside curve, a small outside curve, an inside curve, and two right-angle corners. Taking for the starting point of the cutter the small circle indicated by *A*, the path followed is around the large outside curve, as indicated by the arrows, thence around the two sharp corners to the small inside curve, then to the small outside curve and around as far as point *B*. At this point the cutter is caused to reverse its direction, receding from the work to the position *A*.

In Fig. 1 is shown the head of an ordinary profiling machine. This machine is of the usual type, employing a cutter *A* which operates on the piece *B*. A former pin *C* is automatically kept in contact with the master plate *D*. At *E* is shown a specimen of the work which is profiled. There is also a cutter *F* and a former pin *G* which may be employed when a subsequent profiling operation is to be performed upon the piece. The head of this machine *H*, from which are supported the cutters and former pins, slides laterally upon the frame *I*. This machine was transformed into an automatic profiling machine by adding rail *J*, which was mounted in the outer housings of frame *I*. By means of pin *L*, which can be removed by a hand lever, the head of the machine is made fast to rail *J* so that any movement of rail *J* will carry the head and, consequently, the cutter and former pin with it.

In Fig. 3 is shown a close-range view of the work, the cutter, the master plate and former pin. For doing work of a shape other than the one described, it would be necessary to have a base-plate with provision for holding the piece as well as for mounting the master plate. This, in conjunction with a set of cams, would constitute the requirements for any particular profiling job.

The actual operating mechanism can best be understood by referring to Fig. 4. In this illustration, which shows a plan and elevation of the operating parts of the machine, the head of the machine is indicated as *H* and, as before stated, slides on frame *I*. Here also may be seen the pin *L* which unites head *H* with rail *J*. The work is mounted upon the movable table of the machine indicated as *K* in Fig. 1 as well as in Fig. 4. As table *K* may be moved in a longitudinal

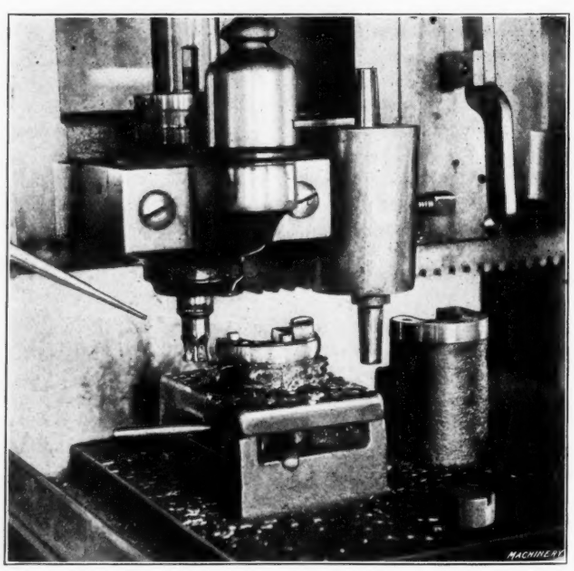


Fig. 3. Close-range View of Cutter, Work, Former and Former-pin

direction and head *H*, in conjunction with rail *J*, may be moved in a lateral direction, it will be seen that it only remains to secure the proper combination of these two movements to follow any desired outline.

The required combination of movements is secured by means of barrel cams *M* and *N*, mounted upon a cam-shaft *O* which is given rotation by means of worm *P* and worm-wheel *Q*, worm *P* being driven through driving pulley *R*. In the groove in cam *M* runs the cam roll *S*. Connecting this roll with work-table *K* is the link *T*. Thus, as cam *M* is slowly rotated, work-table *K*, through link *T*, is caused to advance or recede in agreement with the path of the cam groove. Similarly, a cam-groove is cut in *N*, in which cam roll *U* operates, and by means of bell-crank *V*, fulcrumed on pin *W* on the frame of the machine, the lateral motion of rail *J*, and consequently cutter-head *H*, is effected. It is obvious, therefore, that by securing the proper combination of these two movements the cutter may be caused to follow any desired outline.

The illustration Fig. 5 shows the cams and mechanism employed for profiling the work shown in Fig. 3. The cams shown are about eight inches in diameter, and this size is ample for profiling pieces whose total perimeter does not exceed eight inches. If longer outlines must be traversed, the pitch of the cam groove on an 8-inch diameter cam would be excessive and the feeding of the work-table and cutter-head would not be satisfactorily performed. Therefore on large work it is advisable to use large cam rolls. When employing this principle every distinct job of profiling requires two cams for its accomplishment.

The necessity for having a master plate and former pin in addition to the cams which are used to guide the cutter around any desired outline might be questioned, but by using a master plate and former pin, the action of the machine is made far more steady and, moreover, any slight inaccuracies caused by imperfect cam cutting or wear of the cam groove are corrected by the use of the master plate and former pin, which are indicated as *D* and *C* in Fig. 1. The former pin is always kept in close contact with the master plate without regard to the direction of travel. This is accomplished through "elastic connections" on connecting link *T* and the shaft which passes through rail *J*, which may be seen projecting at the ends of the plan view Fig. 4. The elastic connection on link *T* is indicated as *X* in Fig. 4 and, briefly, it, as well as the one on the shaft which passes through rail *J*, consists of a pair of spiral springs located on each side of a collar, serving to connect the two otherwise separate sections of the shaft. Thus if excessive pressure should be placed upon link *T* through inaccuracy of cam *M*, it would be taken up by this elastic connection and the former pin still kept in normal tension against the side of the master plate. The same results are obtained from a similar construction employed on the shaft passing through rail *J*.

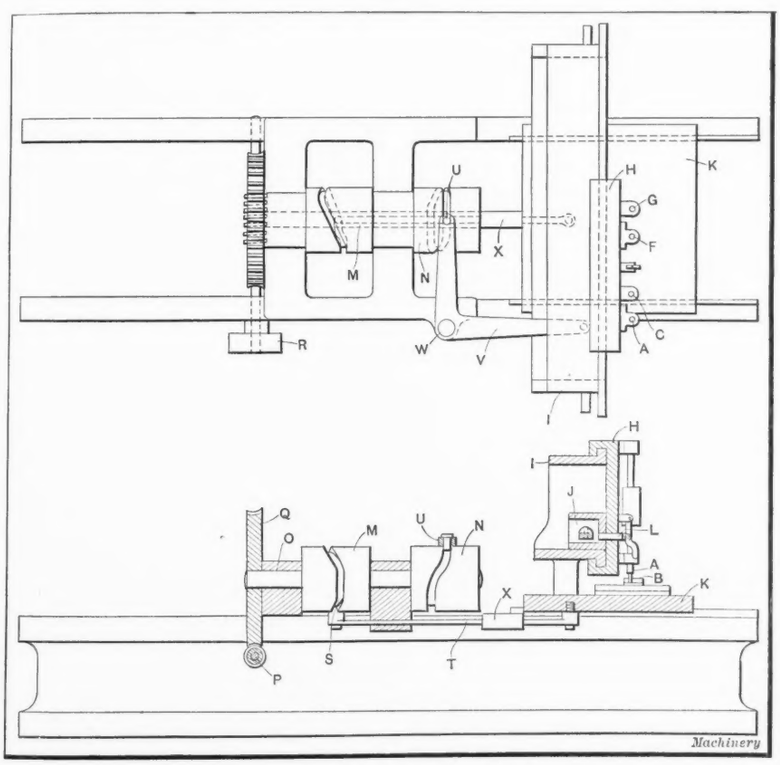


Fig. 4. Plan and Elevation of Cam Mechanism

In operation, the piece, which may be seen at *E* in Fig. 1, is held on the milling fixture as indicated at *B*. The piece is held by an ordinary clamping method. By throwing handle *Z* the machine is started and follows the path indicated in Fig. 2, around the large curve in the direction of the arrows. In Fig. 1 it is shown midway of the inside curve. After rounding the small external curve and on reaching position *B*, in Fig. 2, an abrupt change in the cam groove—which, by the way, may be noticed by referring to the right-hand cam in Fig. 5—reverses the direction of cutter travel, bringing the cutter back to the starting position *A*, when an automatic trip throws out the feed and leaves the cutter stationary. In this position it is away from the work, so that the piece may be removed and a new piece of work inserted. After once locating the piece and throwing the starting lever *Z*, no attention from the operator is required until the insertion of a new piece is necessary.

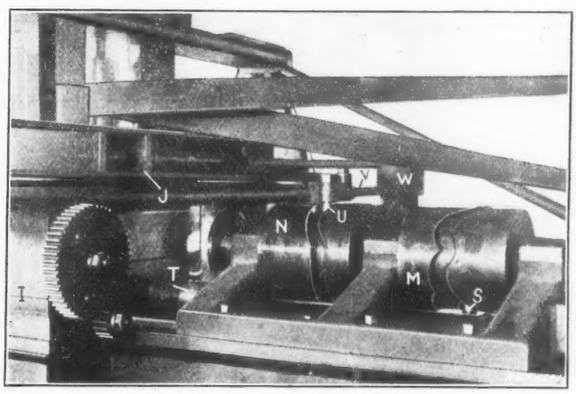


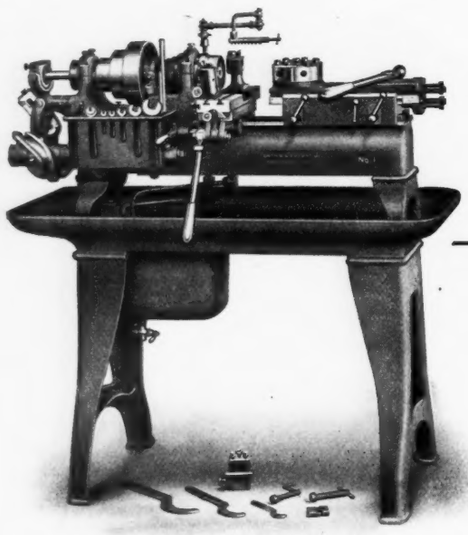
Fig. 5. The Operating Cams

The operation of the machine is smooth and free from "jumpy" action. On the job in question, the cutter moves at the rate of three inches per minute, and as the perimeter of this piece measures practically six inches, the profiling time was two minutes. The device was built by the Spafford Tool Works, Hartford, Conn., and is controlled by Henry G. Newton, 818 Chapel St., New Haven, Conn. C. L. L.

* * *

The U. S. Bureau of Standards has made an investigation with relation to the testing of the hardness of metals, the results of which are reported by Mr. R. P. Devries in a recent report. Five of the most well-known instruments for hardness testing were investigated. The static tests studied were that of Brinell and the cone test. The dynamic test apparatuses used in the investigation were the Shore scleroscope and the Ballantine device. The Bauer drill test for measuring the workability of metals was also included. The tests were made on a series of metals ranging from very hard carbon steel to comparatively soft alloys. The conclusions that may be drawn from the results of this investigation are: (1) That it is possible to obtain rational hardness numerals from static tests, and (2) that static and dynamic tests for hardness do not, in general, agree, except when tests are made on classes of metal having the same texture and general properties. The report of the investigation will be welcomed by users of various means for testing the hardness of metals.

BROWN & SHARPE



Economy in producing pieces where the expense does not warrant setting up automatic screw machines.

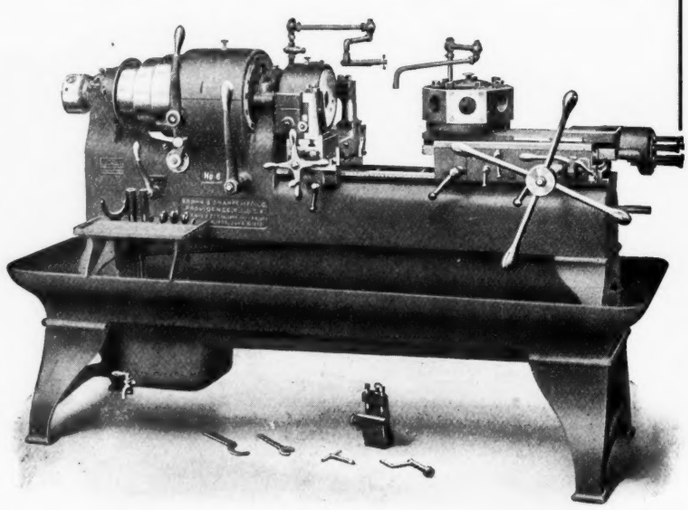
In every shop many lots of a hundred or so of screws, studs, pins, washers, or other pieces are wanted from time to time and the problem is one of producing them most economically. Such jobs do not warrant the time and expense of setting up an automatic screw machine. Neither do they if there are considerably larger quantities, unless lots come along at regular intervals.

For this reason it is advantageous to supplement the automatic screw machines in a shop with

Wire Feed Screw Machines

which are especially adapted for producing this class of work economically.

These machines can be quickly and easily set up and are so arranged that the workmen can operate them rapidly. The chuck and feed for stock are automatic and rapid in operation. All levers and pilot wheels are conveniently located so that the operator does not have to change his position.



Irregular Pieces made from Forgings and Castings

can also be produced to good advantage on these machines by using an ordinary chuck.

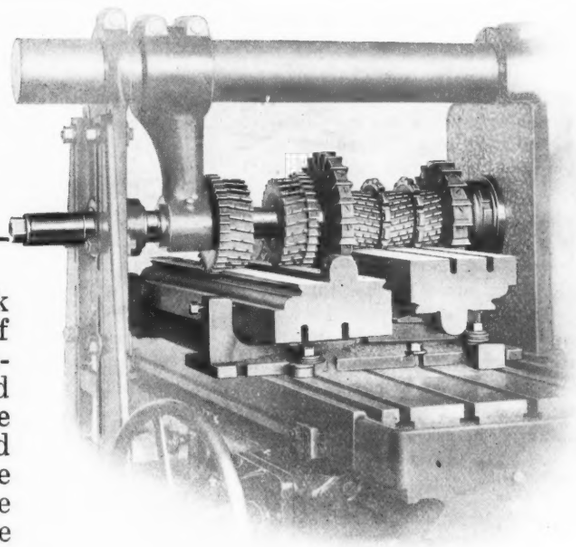
WHAT SIZE MACHINE ARE YOU INTERESTED IN?

BROWN & SHARPE MFG. COMPANY,

See Advertisement on page 75

MACHINE TOOLS

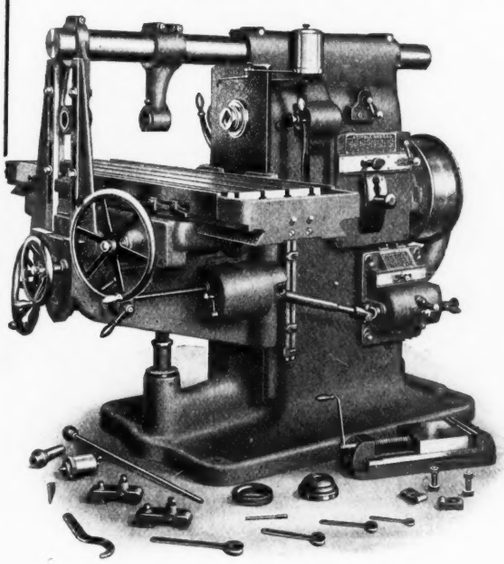
Are there not jobs in your shop that can be milled just as economically as this one?



It is worth while to look your work over, for the pronounced advantages of milling pieces as shown above are unquestionable. On this job a finished milled piece is produced at every traverse of the table. Two pieces are fastened in place and at one cut the top of one piece and bottom of the other piece are finished. The table is then run back, the outer piece removed and the inner piece put in its place. A new piece is substituted for the inner one and the machine is ready for another cut. This job is shown set up on one of our

Heavy Plain Milling Machines

like that illustrated below. These machines are adapted to just such classes of work because of their powerful design. The constant speed type of drive furnishes a constant and maximum amount of power at the spindle at all times, regardless of the spindle speed. The table feeds and spindle speeds are entirely independent of one another, enabling a combination in every case to be selected, that will give a satisfactory finish and production rate.



Write for further information about these machines—they may be the means of saving many dollars in manufacturing similar pieces.

OUR 1913 CATALOG IS READY. DO YOU WANT A COPY?

PROVIDENCE, RHODE ISLAND, U.S.A.

See Advertisement on page 75

NEW TYPE OF WAREHOUSE

A new type of warehouse for storing iron and steel castings has just been completed for the Crocker-Wheeler Co. of Ampere, N. J. It is known as a marine warehouse because its roof construction embraces the principle of the hatchways on a ship. The new building, the only one of its kind, is 85 feet long, 38 feet wide and 13 feet high to the rafters, the capacity being over 40,000 cubic feet. The peak of the slightly sloping roof is fifteen feet high. In each side of the roof there are six big hatch covers 12 feet 10 inches by 10 feet 4 inches, resting on strongly built coamings protected by metal sheathing. A ten-ton traveling crane, running on tracks high enough to give sufficient clearance for the largest castings, is provided to lower the castings into place through the hatchways. This method of handling the castings not only saves the cost of putting in an industrial railway, but also the space necessary to move around small hand cars inside of the building. The hatches are so large that the castings can be put down anywhere, and, thus all of the space can be utilized. The hatch covers themselves are lifted and lowered by the crane. The structure is of wood resting on concrete foundations. The floor consists of solid earth and clay soil smoothed off with cinders to absorb the moisture. The sides are of sheathing and clapboards, and the roof is covered with boards and slag roofing. It is supported by five uprights in the center of the building. The slope of the roof is easy and a handrail along the top prevents the workingmen from falling. Access to it is gained by a stairway at one end. The building is well lighted with twelve windows on each side. The main entrance 10 by 14 feet is closed by two sliding doors, and there is also a small opening at the rear. The building took about six weeks to complete, and cost less than fifty cents a square foot.

* * *

One of the most important requirements for rapid production of machine parts ground from the rough on cylindrical grinding machines, is rigid support for the work, and it is one of those most difficult to meet, especially on long work—chiefly because of the prejudice of grinding machine operators. The Norton Grinding Co., Worcester, Mass., insists that the steadyrests beneath the work shall be brought up firmly against the work while in the rough, whether it be out of round or not. The general run of grinding operators hesitate to do this because they see the shaft sprung out of line and wabbling back and forth. But the irregularity of contour which causes vertical displacement of the work, does not appreciably affect the final accuracy of the ground portion; the reason is that as the roughness is removed the lateral displacement becomes less and less and finally disappears altogether when the work is true. Then the steadyrests supporting the work sideways may be adjusted for the finish grinding. Simple as this procedure is, and as sure to produce good work rapidly, it is still one of the difficult matters for operators to properly understand and apply.

* * *

"FLANGED HEADS"—CORRECTION

The reference letters *E* and *F* on the engraving accompanying the article "Flanged Heads," by R. H. Crevoisie in the January number, were transposed. By changing *E* to *F* and *F* to *E* the apparent errors in the formulas will be corrected.

* * *

PERSONALS

L. F. Hussey has resigned from the position of advertising manager for the Standard Tool Co., Cleveland, O. Mr. Hussey has not yet announced his plans for the future.

Franklin D. Jones, associate editor of MACHINERY, sailed January 8 on the *Laurentic* for a four weeks' cruise to the West Indies, touching at Havana, Cuba; Colon, Panama; and other ports.

William T. Elzinga, for the past four years instructor in the industrial arts at the Stout Institute, Menomonie, Wis., has been appointed instructor of machine construction and forge practice at the State Manual Training Normal School, Pittsburg, Kans.

C. L. Campbell, who was for some years with the Standard Tool Co., Cleveland, Ohio, and later was works manager of the National Twist Drill Co. of Detroit, and during the last year supervisor of tools of the Studebaker Corporation, has resigned to become treasurer and general manager of the Toledo Drill & Tool Co., Toledo, Ohio.

C. E. Allen was recently appointed assistant manager of the detail and supply department of the Westinghouse Electric & Mfg. Co. at East Pittsburg, Pa. Mr. Allen entered the employ of the company in 1909, having formerly been employed by the General Electric Co., where he was in charge of transformer development designs. When in charge of this work, Mr. Allen invented the "distributed core type transformer."

Robert Wuest, for several years commissioner of the National Metal Trades Association, has resigned because of ill-health, and will take a trip abroad to recuperate. Mr. Wuest is succeeded by John D. Hibbard of Chicago, formerly president of the John Davis Co., and for years president of the (former) Chicago Metal Trades Association. Mr. Wuest's resignation takes effect in April following the annual convention, but Mr. Hibbard has already taken up the work of the association in order to familiarize himself with its many details.

* * *

OBITUARIES

M. B. Stauffer, foreman of the toolroom of the Crescent Mfg. Co., Scottdale, Pa., and an occasional contributor to MACHINERY, died of typhoid fever November 30, aged twenty-nine years.

Edward O'Connell, formerly chief constructor of the U. S. Navy, under whom the famous armored turret vessel the *Monitor*, designed by Captain John Ericsson, was built, died January 20, aged eighty-five years. The *Monitor* was the progenitor of the modern battleship.

Samuel F. Hall, chief engineer with the Norton Co., Worcester, Mass., died from injuries received in an elevator January 8. Mr. Hall was a graduate of the Worcester Polytechnic Institute, class of 1900, and since then, until within a few weeks, had been in the employ of the Norton Co. at its Niagara Falls and Chippewa plants.

F. E. Maxon, who for the past three years was connected with the New York sales department of the Independent Pneumatic Tool Co. of Chicago, as assistant to R. S. Cooper, manager, died January 8 from an attack of appendicitis. Mr. Maxon was formerly employed by the Rutland R. R. and was later chief clerk to the inspector of tools and machinery N. Y. C. & H. R. R. R.

* * *

SOCIETIES, SCHOOLS AND COLLEGES

STEVENS INSTITUTE OF TECHNOLOGY, Hoboken, N. J., announces a special engineering lecture course for Stevens students, comprising six lectures on shop management, by John Calder of the Cadillac Motor Car Co.; four lectures on contract law, by H. E. White; four lectures on patent law, by W. R. Baird; two lectures on boilers and power plants, by Dr. J. S. Jacobus of the Babcock & Wilcox Co.; two lectures on heating and ventilating, by Mr. Henry C. Meyer, etc.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 33 W. 39th St., New York, through its board of directors, has adopted a set of resolutions urging Congress to provide for a commission made up of unbiased, independent, non-partisan men, chosen from different walks of life and serving without pay, to hold public hearings and make a careful and thorough study of the American patent situation, and to prepare and submit a comprehensive report and recommendations to Congress for such changes as in their judgment are required in the patent office, in the method of court procedure, or in the organic patent law and for legislation that should be enacted.

COMING EVENTS

February 25-27.—Convention and exhibit of the New England Hardware Dealers' Association in the new municipal auditorium, Springfield, Mass.

May 20-23.—Spring meeting of the American Society of Mechanical Engineers in Baltimore, Md. Hotel Belvedere, headquarters. Layton F. Smith, past president of the Baltimore Engineers Club, chairman of the local committee. Calvin W. Rice, secretary, 29 W. 39th St., New York.

May 26-29.—Annual convention of the Master Boiler Makers' Association at Chicago. Harry D. Vought, secretary, 95 Liberty St., New York.

June 10.—Departure from New York of American Society of Mechanical Engineers party to attend joint meeting with Verein deutscher Ingenieure in Leipzig, Germany, beginning June 23.

June 11-13.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 16-18.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

NEW BOOKS AND PAMPHLETS

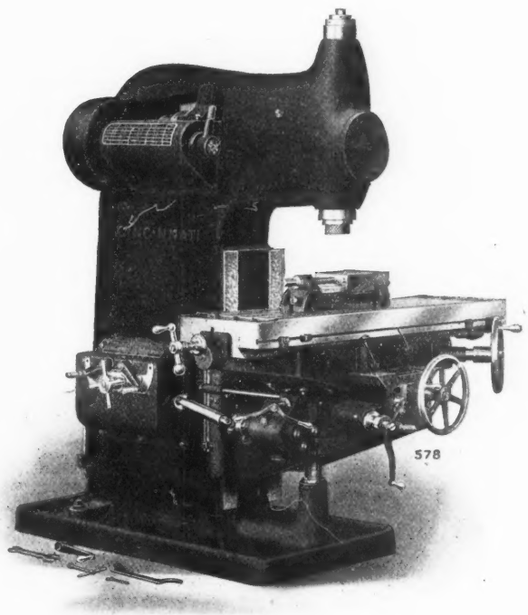
THE PROPOSED PATENT LAW REVISION. By Gilbert H. Montague, 40 Wall St., New York. 18 pages, 6¾ by 10 inches. Reprinted from the *Harvard Law Review*.

MISSION FURNITURE, HOW TO MAKE IT. 120 pages, 4½ by 7 inches, numerous illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price 50 cents.

STEAM BOILERS. By H. DeB. Parsons. Second Edition. 377 pages, 9¼ by 6¼ inches. 156 illustrations. Published by Longmans, Green & Co., New York. Price, $4, net.

SPECIFICATIONS FOR AND MEASUREMENT OF STANDARD SIEVES. 14 pages, 9⅞ by 7 inches. Prepared by the Bureau of Standards of the Department of Commerce and Labor, Washington, D. C.

WIRELESS TELEGRAPHY AND TELEPHONY SIMPLY EXPLAINED. By Alfred P. Morgan. 154 pages, 7½ by 5¼ inches. 156 illustrations. Published by Norman W. Henley & Son, New York. Price, $1.



The No. 2 Vertical Cincinnati Miller

High Power Design with Cone Drive

This is a modification of our No. 2 Vertical Single Pulley Machine. We have substituted a large 4-step cone with back gears in place of the geared spindle drive mechanism.

It is especially adapted for manufacturing small machine parts, particularly those that require a degree of accuracy that can only be produced on a rigid machine.

It also has many features of handiness that give it special value for die making and similar work.

The operator can change the direction of the table movement—longitudinal to cross and back again—by the two levers at the front.

He always moves the levers in the direction he wants the table to go. There is no lever down under the table at the back of the knee for determining the direction or reversing. All levers are at the front with the operator.

It is easy to mill around the periphery of a rectangle because the changes in direction can be made without stopping. In fact, both longitudinal and cross feeds can be used in combination when it is profitable to do so.

These things make the man's task easier, enable him to operate the machine quicker and produce more work.

Send us your blue prints and we will show how this applies to your work.

THE CINCINNATI MILLING MACHINE COMPANY, Cincinnati, O., U.S.A.

EUROPEAN AGENTS—Alfred H. Shutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Aires.

WINDING ENGINES AND WINDING APPLIANCES. By George McCulloch and T. Campbell Futers. 452 pages, 9½ by 6⅜ inches. 174 illustrations. Published by Longmans, Green & Co., New York. Price, $6, net.

THE SHERMAN ANTI-TRUST ACT AND THE PATENT LAW—THE SUPREME COURT ON PATENTS (THE DICK PATENT CASE). By Gilbert H. Montague, 40 Wall St., New York. 55 pages, 6½ by 10 inches. Reprinted from the *Yale Law Journal*.

THE GIST OF THE SUPREME COURT DECISION IN THE DICK PATENT CASE AND OF THE PROPOSED PATENT LAW AMENDMENTS. By Gilbert H. Montague, 40 Wall St., New York. 21 pages, 7 by 10 inches. Reprinted from the *Engineering Magazine*.

POPULAR MECHANICS YEAR BOOK FOR 1913. 214 pages, 9½ by 6½ inches. Illustrated. Published by *Popular Mechanics*, Chicago, Ill. Price, 50 cents, net.

The present issue, which is Vol. IX, of the Popular Mechanics Year Book, contains illustrated descriptions of 595 ways of doing various mechanical operations in the shop, home and office.

THE COKING OF COAL AT LOW TEMPERATURES. By S. W. Parr and H. L. Olin. 46 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill.

This bulletin, which is No. 60 of the Engineering Experiment Station of the University of Illinois, reports the results of experiments on various types of Illinois coal with reference to the principles which govern their use in the production of coke. Reference is also made to the by-products obtained.

SAW FILING AND MANAGEMENT OF SAWS. By Robert Grimshaw. 133 pages, 4 by 6 inches, 106 illustrations. Published by Norman W. Henley & Son, New York. Price $1.

This is the third edition of a book designed as a practical aid to those who use saws for any purpose. While it treats principally of saw filing, it also deals with such questions as gumming, spring-setting, and swaging. The third edition has been revised and considerable new material added in order to bring the book up-to-date.

HENLEY'S TWENTIETH CENTURY BOOK OF RECIPES, FORMULAS AND PROCESSES. Third Edition. Edited by Gardner D. Hiscox. 787 pages, 9¼ by 6½ inches. Published by Norman W. Henley & Son, New York. Price, $3.

The information in this book is arranged alphabetically and covers a wide range of recipes and formulas of value to the mechanic and manufacturer. The data is not based on actual experiments, but, as far as possible, the accuracy of the methods outlined has been verified by the editors.

PRACTICAL MATHEMATICS. By Claude Irwin Palmer. 176 pages, 7 by 4¾ inches. 31 illustrations. Published by McGraw-Hill Book Co., New York. Price, 75 cents, net.

Parts I and II of this series dealing with the subjects of arithmetic and geometry were reviewed in the December issue of MACHINERY. The present volume, which is Part III, covers the subject of algebra, the object of the author having been to present the subject in a way which will make it particularly suited for the requirements of practical men who are "brushing up" their knowledge of mathematics.

BEST'S KEY RATINGS OF FIRE INSURANCE COMPANIES. 108 pages, 4¼ by 8¼ inches. Published by Alfred M. Best Co. Inc., 100 William St., N. Y. Price, $5.

This compilation of ratings includes all licensed joint-stock fire insurance companies except re-insurance companies, and all of the "surplus line" fire insurance companies and associations operating in the United States. Comparative underwriting and financial exhibits for five years are also included. The value of insurance company ratings is obvious to all who have the responsibility of placing fire insurance.

INDUSTRIAL DISEASES. 417 pages, 6 by 9 inches. Published by the American Association for Labor Legislation, 131 E. 23d St., New York City. Price $1.

This book, which is No. 2 of the second volume of publications of the American Labor Legislation Review, contains a symposium on diseases of occupation, an investigation of industrial diseases and of health problems in modern industries, and a review of the progress of state promotion of industrial hygiene. A list of books published on industrial diseases and their prevention, is also included, this list being quite complete in its scope.

BOOK OF STANDARDS. 600 pages, 4 by 6½ inches. Published by the National Tube Co., Frick Bldg., Pittsburg, Pa. Price, $2.

This handbook is for engineering use in connection with tubular material, pipe and pipe fittings, and contains information on manufacture, sizes, weights, dimensions, test pressures, sections of joints, physical and chemical properties, bursting, collapsing and column strength of all pipe and tubular goods manufactured by the National Tube Co. Other sections of the book are devoted to information on air, gas, water and steam. In addition, there is a glossary defining a large number of terms used in the pipe and fitting trade.

THE "MECHANICAL WORLD" ELECTRICAL POCKET BOOK FOR 1913. 240 pages, 4 by 6 inches. 98 illustrations. Published by Emmott & Co. Ltd., 65 King St., Manchester, England. Price sixpence.

In the 1913 edition of this popular little handbook, 16 pages of useful information for the electrician have been added and some sections have been rewritten and expanded. This is especially the case with the sections dealing with dynamos, motors and electrical measuring instruments. A new section on magnetic circuits and magnetic materials has been introduced, and space has also been devoted to electric motor applications, motor control by switches, depreciation, etc.

CALCULATIONS ON THE ENTROPY-TEMPERATURE CHART. 74 pages, 5 by 7½ inches, 52 illustrations. Published by J. B. Lippincott Co., Philadelphia, Pa.

The author of this book, who is a lecturer in mechanical engineering at the Municipal and Technical Institute, Belfast, Ireland, has endeavored in this book to show students who are not well versed in the theory of thermo-dynamics, how to make use of the entropy-temperature chart. For this reason, the matter has been treated as simply as possible and a complete knowledge of the principles underlying entropy is not necessary. The purpose of the book is thus a thoroughly practical one and it should be useful to students who want to be able to use entropy-temperature charts without going into complete details as regards their theory.

THE GAS TURBINE. By Hanz Holzwarth. Translated by A. P. Chalkley. 138 pages, 6 by 9 inches. 142 illustrations and several folding tables. Published by J. B. Lippincott Co., Philadelphia, Pa. Price $2.50.

This book deals with the theory, construction, and records of results obtained from two actual gas turbines, and contains information concerning systematic investigation work with regard to machines of this kind which has now been proceeding for more than three years. The book is divided into four general parts of which the first part comprises about one-half of the book and deals with the theory of the gas turbine. The second part deals with the construction of the particular gas turbines tested. In the third part, general comparison is made between the gas turbine and reciprocating gas engines, and in the fourth part are given the results of the tests made on the gas turbines described.

AN EXTENSION OF THE DEWEY DECIMAL SYSTEM OF CLASSIFICATION APPLIED TO THE ENGINEERING INDUSTRIES. By L. P. Breckenridge and G. A. Goodenough. 117 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill. Price, 50 cents.

The filing and classification of engineering data have become matters of much importance, and this bulletin was prepared for use as a guide in carrying out such work. The original edition of Bulletin No. 9 was gratuitously distributed and it met a general want. A second edition was printed and altogether 20,000 copies were sent out free. The demand having continued, it was decided by Dr. Goss, director of the engineering experimenting station, to revise and print a limited edition which will not be distributed free, but which will be sent postpaid on receipt of 50 cents. The revised bulletin is much extended as compared with the original edition. It presents subdivisions of subjects in such detail as to constitute a complete classification for most engineering industries, even though they are highly specialized. The revision was made in accordance with the 1911 edition of the "Decimal Classification" by Melvil Dewey.

THE ELEMENTS OF MACHINE DESIGN. II. By W. Cawthorne Unwin and A. L. Mellanby. 426 pages, 5¼ by 8¼ inches. 311 illustrations. Published by Longmans, Green & Co., New York. Price $2.50.

Machine designers generally, and engine designers in particular, will welcome the revised edition of Part II of Prof. Unwin's well-known work, which is devoted chiefly to engine details. The revised editions of both Part I and Part II are enlarged in size of page, number of pages and illustrations and scope. The revision was made with the aid of Prof. Mellanby who used the work for years as a text-book in the Royal Technical College of Glasgow. While Unwin's work, in common with others on machine design, is largely a collection of rules and data derived from precedent, the effort throughout is to give reasons for arrangements or proportions and thus establish rational methods of design. The contents by chapter heads are as follows: On Pipes and Cylinders; Arrangement and Proportions of Steam Engine Cylinders; Indicator Diagrams; On the Kinematical and Dynamical Problems in Engine Designing; Balancing; Cranks, Levers and Eccentrics; Pistons and Piston-Rods; Connecting-Rods; Cross-heads and Slides; Stuffing-boxes; Flywheels; The Steam Engine Governor; Valves, Cocks and Sliding Valves; Condensers; Steam Engine Valves; Valve Diagrams; Expansion Valves; Link Motion and Reversing Gears; Lubricators. The book is one that we heartily commend for designers, draftsmen and progressive mechanics generally who are interested in the theory and practice of machine design.

NEW CATALOGUES AND CIRCULARS

WHITMAN & BARNES MFG. CO., Akron, Ohio. Folder on "W. & B.", "Diamond" and "Hercules" twist drills.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Bulletin on Type G controllers for direct-current motors.

NEW JERSEY FOUNDRY & MACHINE CO., 90 West St., New York. Circular of cranes, tracks, trolleys and hoists for indoor and outdoor service.

OHIO VALLEY PULLEY WORKS, Maysville, Ky. Discount card of "Limestone" wood split pulleys in celluloid case, arranged for convenient use.

EMERSON ELECTRIC MFG. CO., St Louis, Mo. Bulletin No. 3313 on electric forge blowers, direct-connected, for direct and alternating currents.

DOEHLER DIE-CASTING CO., Court & Ninth Sts., Brooklyn, N. Y. Circular of babbitt-lined bronze bearings which are formed by rolling and pressure, instead of being melted and cast in molds.

STANDARD ELECTRIC TOOL CO., Cincinnati, Ohio. Bulletin U-7 on the "Standard" high-power universal portable electric drills, made to operate on alternating and direct current, 110 to 220 volts.

WILLIAM F. WOLFF CO., 32 Union Square, New York. Circular on "Any Wheare" lamp brackets for use in offices, drafting rooms and all places where an adjustable bracket electric light is advantageous.

CARROLL-JAMIESON MACHINE TOOL CO., Batavia, Ohio. Circulars of 14-inch single back-gear quick change gear lathe (15¼ inches swing) and 14-inch double back-gear quick change gear lathe (15¼ inches swing.)

LEA-COURTENAY CO., INC., 90 West St., New York. Catalogue of Lea-Courtenay turbine pumping machinery illustrating the construction of the turbine pump and showing examples of various sizes and combinations.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa. Circular of Westinghouse commutator cement for repairing pitted commutators, filling grooves in undercut commutators and for insulating inaccessible places.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin A 4069 on portable and stationary air compressor sets; 4994 on subway transformers; A 4065 on electric hardening furnaces type RHF; and A 4065 on electric fans for 1913.

INDEPENDENT PNEUMATIC TOOL CO., Thor Bldg., Chicago, Ill. Circular of "Thor" close-quarter piston air drills, made in two sizes, Nos. 8 and 9, the first operating within 1 5/32 inch from corner, and the second 1 9/32 inch from corner.

MEISSELBACH-CATUCCI MFG. CO., 29 Congress St., Newark, N. J. Bulletin No. 3, illustrating and describing the company's No. 1 M-C turret head which is designed to be readily adapted to any bench lathe, thus converting it into a screw machine.

BETTS MACHINE CO., Wilmington, Del. Booklet illustrating Betts machine tools in use by prominent railroads, comprising boring and turning mills, tire turning mills, car-wheel boring mills, horizontal boring and drilling machines, slotting machines and planing machines.

KEUFFEL & ESSER CO., 127 Fulton St., New York. Circular of the K & E power computing slide-rule for computing power and dimensions of steam, gas and oil engines, solving the equation $H.P. = \frac{PLAN}{33{,}000}$

HYDRAULIC TRUCK SALES CO., 1777 Broadway, New York. Circular on the La France gasoline-hydraulic truck, illustrating the principle of the hydraulic variable speed mechanism, by which the velocity ratio of the engine to the drive wheels can be changed by minute increments.

LUMEN BEARING CO., Buffalo, N. Y. Booklet on casting alloys and babbitt metals, comprising bronze, brass and aluminum alloys and different grades of babbitt metals. The physical characteristics of the various alloys are given, and the services for which they are particularly suited.

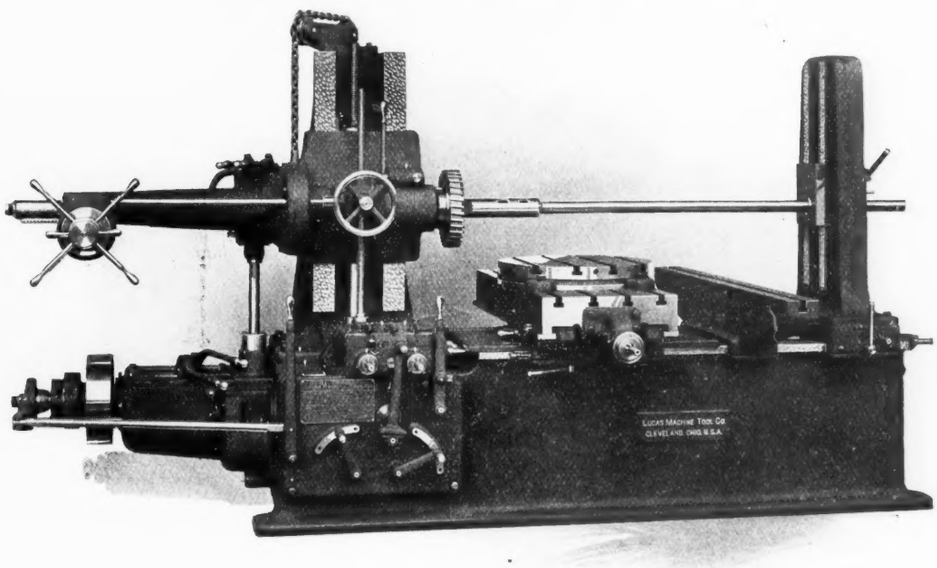
M. A. HASKELL & CO., 12 Summer St., South Braintree, Mass. Leaflet illustrating the Haskell universal three-jaw clamp, for the use of patternmakers, cabinet makers, picture framers, carpenters and machinists. The tool may be used over a three-jaw clamp or two-jaw clamp, as required.

THOS. H. DALLETT CO., York & 23d Sts., Philadelphia, Pa. Bulletin No. 303 on the Dallett "quick action" hose coupling which provides

IT IS WASTE LABOR

to manipulate two or more levers when one will accomplish the desired end, or to manipulate anything by hand when power will do the work. It is worse than *waste labor* when a man engages the wrong feed, or engages another feed when one is already engaged and smashes something in consequence. You will find none of these or other disadvantages on the

"PRECISION"
Boring, Drilling and Milling
MACHINE



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SIMPLICITY
SOLIDITY
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LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

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means for quickly connecting or disconnecting hose and which is particularly adapted to compressed air equipment in shops, foundries, mines, quarries, etc.

Sawyer Tool Mfg. Co., Ashburnham, Mass., is publishing a house organ called the *Sawyer Bulletin* which will be sent free to machinists, toolmakers and others interested in fine machinists' tools. The bulletin illustrates new Sawyer tools and contains funny stories, jokes and road experiences.

Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Catalogue of the Beaudry power hammers, comprising Beaudry "Champion" 50- to 500-pound rams and the Beaudry "Peerless" 25- to 200-pound rams. The two styles are illustrated in detail, and sizes and dimensions of both styles are tabulated.

W. S. Rockwell Co., 50 Church St., New York. Circular of the Rockwell tilting crucible melting furnaces for aluminum, bronze, brass, copper, gold, silver and other non-ferrous metals. The furnaces are designed to use either oil or gas fuel, and are made in four sizes having working capacities of 200 to 1600 pounds.

Cleveland Twist Drill Co., Cleveland, Ohio., is distributing a handsome wall calendar for 1913. A feature of general interest and value to machinists is tables of tap drill sizes for U. S. standard threads, pipe threads, A. L. A. M. standard threads, and machine screw threads.

Duplex Gasoline Motor Co., 42d St. & Broadway, New York. Circular of "Twostrok" four-cylinder gasoline motor, having only seventeen moving parts. It is claimed that the "Twostrok" motor is economical of gasoline, comparing favorably with any four-cycle or two-cycle motor of the same size. The motor has no rotary valves nor poppet valves.

Keuffel & Esser Co., 127 Fulton St., New York. Catalogue of drawing materials, surveying instruments and tapes, comprising a large variety of materials, supplies, instruments and apparatus used in drafting-rooms, engineers' offices, by surveyors, mathematicians, etc. Colored inserts show drawing instruments and equipment of a drawing-room and a transit.

Lindhe Shim Co., 210-212 Canal St., New York. Circular of the Lindhe shim for machinery bearings, etc., which is composed of laminated brass sheets 0.002 inch thick, held together by a metallic binder. These shims have all the solidity of the ordinary all-metal shim and the advantage that the thickness can be reduced by simply peeling off one or more layers as required.

Chicago Pneumatic Tool Co., Chicago, Ill. Bulletins E-22, on heavy-duty electric drills for alternating current; E-26, on "Universal" electric drills operating on direct or alternating current; E-27, on heavy-duty electric drills; 34-G, on air receivers, after-coolers, air line drain traps, reheaters and economizers; and 34-F on the design and construction of class G "Chicago-Pneumatic" air compressors.

Sprague Electric Works of the General Electric Co., New York. Bulletin No. 117 on electrical equipment for buildings, comprising generators, gasoline-electric generating sets, motor generators, switchboards, conduit boxes and fittings, wire and cable, wiring devices, panel boards, direct- and alternating-current motors, controllers, electric hoists, electric fans, lamps, ozonators, theatrical devices, etc.

Doehler Die-Casting Co., Court & Ninth Sts., Brooklyn, N. Y. Circular on molded brass parts made from brass heated to a semi-fluid or plastic state and subjected in molds to a high pressure. The alloy used is golden yellow in color, and is easily machined. It has a tensile strength of 55,000 pounds per square inch, an elastic limit of about 22,000 pounds and an elongation in six inches of about 20 per cent.

Motch & Merryweather Machinery Co., 707-715 Lakeside Ave., Cleveland, Ohio. Catalogue of machine tools and other accessories made by sixty well-known concerns for whom the company is the representative. The catalogue contains 445 pages, 9 by 11 inches, and is fully illustrated throughout. The value of this catalogue to purchasing agents and others concerned with the purchase of machine tool equipment, is obvious.

Superior Machine Tool Co., Kokomo, Ind., Bulletins 160 and 250-C on Kokomo "Hi-Speed" roller bearing sensitive drilling machines, and "Hi-Speed" vertical drilling machines. The sensitive drilling machines are made in 16-inch and 20-inch swing and in single spindle and multiple spindle combinations. The vertical drilling machine is 25-inch swing exclusively, and is furnished with friction back-gears, friction quick-return, positive gear feed, tapping attachment, etc.

Eveland Engineering & Mfg. Co., 2324-2328 Market St., Philadelphia, Pa. Circular of electric riveters with which rivets are heated and headed by electric current and pressure without welding. Advantages claimed for electric riveting are: any shape of rivet head can be produced, the most fragile articles can be riveted without danger of breakage, and rivets of high carbon steel, nickel-chrome steel, etc., can be headed as readily as rivets of soft steel.

W. P. Davis Machine Co., Rochester, N. Y. Circulars of 12- to 16-inch swing engine lathe with motor drive, quick change gear box; 18- to 32-inch swing engine lathe with motor drive, quick change gear box; 14-inch Davis tool-room lathe with quick change feed gear box, oil-pan and draw-in attachment; 16-inch Davis lathe with turret on carriage, quick change gear and taper attachment; 20-inch Davis back-gear and power feed drilling machine, with square table; and 6-inch Davis cut-off machine.

Bath Grinder Co., Fitchburg, Mass. Booklet of useful information on Bath universal grinding machines, comprising description of the machine and attachments with illustrations showing construction of machine and the attachments set up for use. The illustrations of attachments are partial phantom views, the machine proper being in phantom and the attachments in full. Directions for grinding cutters and reamers are included and other useful information on grinding wheels, work and traverse speeds, wheel grades, etc.

Hendey Machine Co., Torrington, Conn. Catalogue of screw cutting engine lathes, comprising 12-inch to 32-inch swing inclusive, with regular belt-cone driven heads; 12-inch to 24-inch swing inclusive, with all-geared drive heads; and a modified geared drive head for 32-inch swing, designed for variable speed motor drive. The catalogue contains 147 pages, 6 by 9 inches, and is fully illustrated. It shows a large number of attachments and accessories of general interest to mechanics, especially those concerned with the equipment of toolrooms. Data is included on calculating change gears for thread cutting, etc.

Doehler Die-Casting Co., Court & Ninth Sts., Brooklyn, N. Y. Pamphlet entitled "Successful Die-Casting" illustrating the new Doehler factory and many examples of die-cast parts which illustrate the remarkable possibilities of the die-casting process. Manufacturers generally, and those particularly making small machinery and apparatus such as magnetos, motor starting devices, electric horns, electrical apparatus generally, automatic vending machines, cash registers, coin counting devices, force-feed oil pumps, carbureters, etc., will find the pamphlet of much suggestive value.

National Machine Tool Builders Association. James H. Herron, Cleveland, Ohio, secretary. Official report of the eleventh annual convention held in New York City at the Hotel Astor October 16, 17 and 18. The report includes the interesting papers: "Export Trade" by W. A. Viall; "The Use of an Association Catalogue in the Development of Foreign Markets" by S. H. Bullard; "How United States Patents Might be Made of Greater Value to Patentees" by S. W. Banning; and "How Could the Association be Benefited by the Formation of a Mechanical Section?" by E. J. Kearney.

Vulcan Engineering Sales Co., Fisher Bldg., Chicago, Ill. Bulletins illustrating several styles and sizes of Q-M-S cold metal-sawing machinery, comprising style 1M saw with capacity for 6-inch rounds and squares and 10-inch I-beams; B cut-off and universal type, motor-driven through belting from motor to machine; A or B type universal machines which may be used either as metal-sawing machines or milling machines, the saw being replaced with a milling cutter, thus combining two machines in one; A, cut-off and universal type machine, arbor-driven, using inserted-tooth saw blades and having feed of the variable adjustable friction type; foundry type of cold metal cut-off machines, being the B cut-off type machine arranged especially for foundry use. The bulletins are profusely illustrated and of general interest to users of metal-sawing machines such as bridge works, structural steel works, machine shops, foundries, etc.

TRADE NOTES

St. Louis Machine Tool Co., formerly of 1209-1211 Gratiot St., St. Louis, Mo., has moved to 2607-2609 South Broadway, St. Louis.

Barcy-Nicholson Co., Detroit, Mich., has taken over the business of the Universal Stamping Co., Buffalo, N. Y., and is manufacturing the "Universal" safety devices.

Cleveland Worm & Gear Works, 66th St. and St. Clair Ave., Cleveland, Ohio, is a concern recently organized for the manufacture of worm-gears for automobiles and trucks.